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Bulletin 47 September 1901

MAR 1 1913

AQUATIC INSECTS IN THE ADIRONDACKS

A study conducted at the Entomologic field station, Saranac Inn N. Y. under the direction of

Ephraim Porter Felt D. Sc. *State entomologist*

BY

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AND

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Bulletin 47 September 1901

AQUATIC INSECTS IN THE ADIRONDACKS

PREFACE

The following account presents in part the results obtained by a close study of aquatic insects in one locality. Saranac Inn proved an exceptionally favorable place for investigations of this character, and the labor of two earnest, enthusiastic workers made the entomologic field station a very successful institution. Only 10 weeks in the field sufficed for working out in more or less detail the life histories of about 100 species, the discovery of 10 new species and two new genera, and for material additions to the list of insects known to occur in the state. The bred Chironomidae, the material representing the suborder Zygoptera of the dragon flies and the collection of fish stomachs, which have not been included in this report, should give, when worked up next year, a large number of additional interesting and valuable facts.

This work, even when all available data are brought together, does not complete the desirable investigations along this line. Dr Needham's report, though thorough so far as it goes, is largely of a preliminary nature and will prove an excellent basis for subsequent work. It is physically impossible to do more than this with 10 weeks in the field. The solving of the complex interrelations existing between the various aquatic forms requires persistent efforts extending through a number of seasons, and the results thus obtained should be verified by studies in other localities. This is a large field requiring the serious attention of the botanist and zoologist, using these terms in the general sense, and the practical value of these studies can not be fully available till such an investigation is made along broad and comprehensive lines. A study of this character could be conducted at a comparatively small outlay, and would prove of great benefit to fish culture, and should result in the rearing of many more fish in the fresh waters of New York state.

E. P. Felt

State entomologist

39728

Part 1

INTRODUCTORY

THE UNDERTAKING, LOCATION, OBJECTS, METHODS AND RESULTS

"To collect and study the habits of aquatic insects, paying special attention to the conditions necessary for the existence of the various species, their relative value as food for fishes, the relations of the forms to each other, and their life histories": such were the instructions under which I went to Saranac Inn, to take charge of the opening session of the entomologic field station. Arrangements had been previously made with state entomologist Dr E. P. Felt, that the session should extend from June 15 to August 20. I arrived at Saranac Inn on the evening of June 12, and at once began looking the ground over. Dr Felt came on the 14th, and spent the day with me canvassing the situations to be studied. My assistant, Cornelius Betten, arrived on the 15th, and the regular work of the session was at once begun, to be continued without cessation to the date of closing.

Through the courtesy of the New York state fisheries, game and forest commission the station was furnished with working quarters in the hatchery building, and was allowed the use of parts of the hatchery equipment, not then otherwise needed. There were three very considerable advantages to our work in this arrangement: 1) the use of several hatching troughs with their continuous supply of well aerated water for insect breedings, 2) the use of a carpenter's bench and tools for the construction of special breeding cages, 3) the use of a boat for collecting.

We were soon supplied with a special equipment for the collecting and rearing of aquatic insects, that was excellently adapted to our needs, and without which the work hereinafter recorded could not have been done. Our sincere thanks are due Dr Felt for his care in providing exactly the apparatus asked for. Save for the first 10 days, during which we were unable to find living quarters within 2 miles of our field of operations, we had the still farther great advantage of close proximity to good collecting grounds.

The season was one of excessive rainfall. The first week of the session and the last one were comparatively dry; but, for the remainder, it was raining more than a third of the time. Thus collecting was greatly interfered with, sweeping of vegetation was almost prevented, trap lanterns were flooded night after night and their catch spoiled, and regularity in field operations was made impracticable.

The routine work of the station consisted in collecting and studying aquatic insects in all their stages of development, in conducting feeding

experiments, in making quantitative studies of the life of certain situations, in gathering the materials for the study of the natural and habitual food of trout, bullfrogs, and some of the larger species of dragon flies, in running trap lanterns and sending their nightly catch to the state museum, etc.

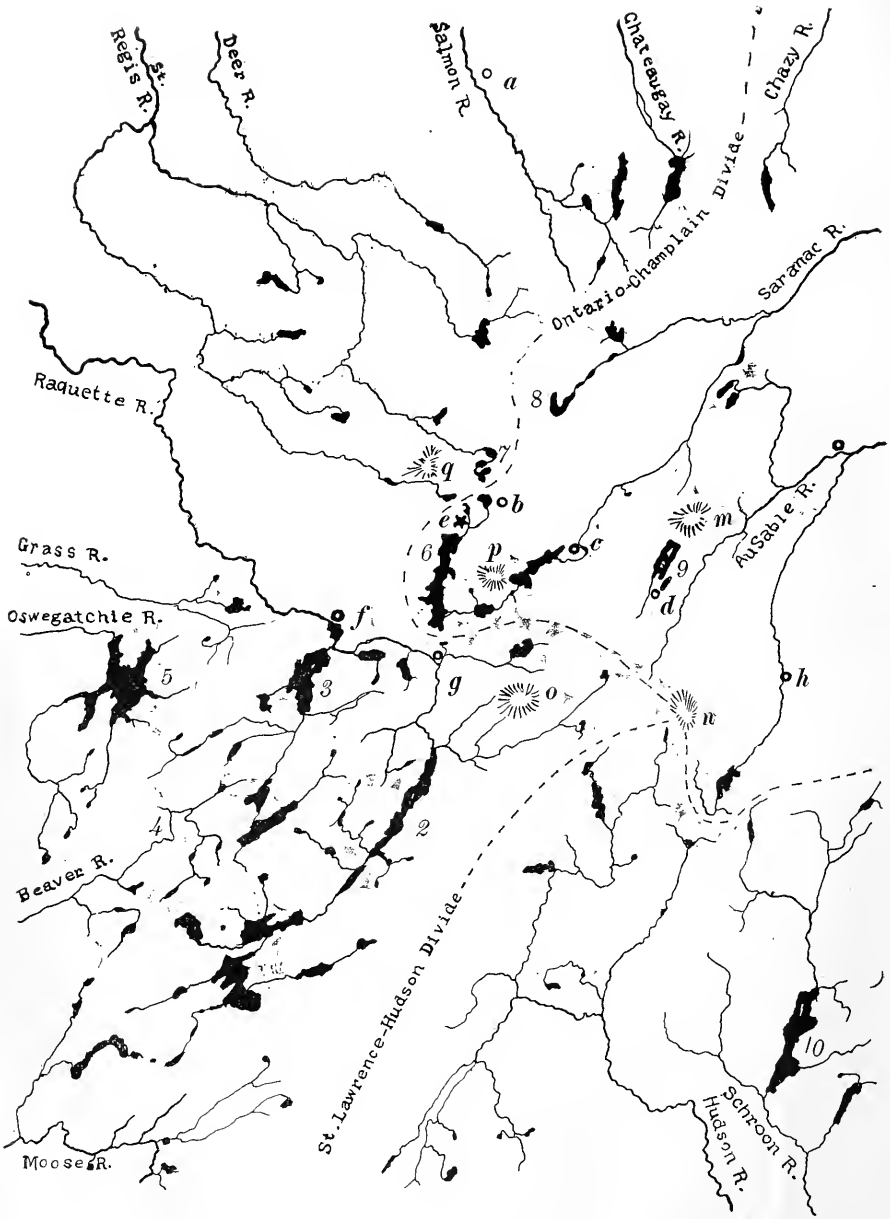
Besides three official visits made by Dr Felt during the course of our session, our station was visited for a week or more at a time by three scientific friends, who, while there, participated in our operations, and, while collecting for themselves, gathered also valuable materials and information for us. These were Louis W. Swett of Malden Mass., H. N. Howland of Austin Ill., and Dr O. S. Westcott of Chicago. It is a pleasure to acknowledge the assistance gratuitously rendered by these gentlemen.

Biologic features of the locality

As is well known, the Adirondack region of northeastern New York is an extensive area of forest, having an average elevation of about 1800 feet. Its eastern half is covered with a succession of low mountain ranges, whose general n n e-s s w trend is indicated on the accompanying map (map 1) by the trend of the streams which occupy the narrow valleys between them. The western half is a region of lakes and swamps and bogs, with scattered mountains and hills and ridges.

Map 1 shows the principal streams that participate in the drainage of the Adirondack region, the principal lakes, and some of the mountains. It will be observed that the lake region of the Adirondacks is drained principally through Racket river into the St Lawrence.

Saranac river is the only one on the Champlain side that drains any considerable part of the lake country. Our station at Saranac Inn was at the head of the Saranac drainage system. Map 2 shows the immediate field of our operations. As stated above, the hatchery was our working headquarters. We did more collecting from Little Clear creek right on the hatchery grounds than from any other equal water area, and obtained more material of value there than in all other places combined. More or less regular collecting was done, however, from the three propagating ponds, Little Clear, Little Green and Bone, and from Little Bog pond, southwest of the railroad station. Two collecting trips were made to each of the following places: Colby pond, at the western outskirts of the village of Saranac Lake; Stony brook, just north of Axton; and St Regis pond, at the end of the carry from Little Clear. The mornings and evenings of the first week of the session were spent gathering material about the south shore of Lake Clear, or Big Clear at Otisville.

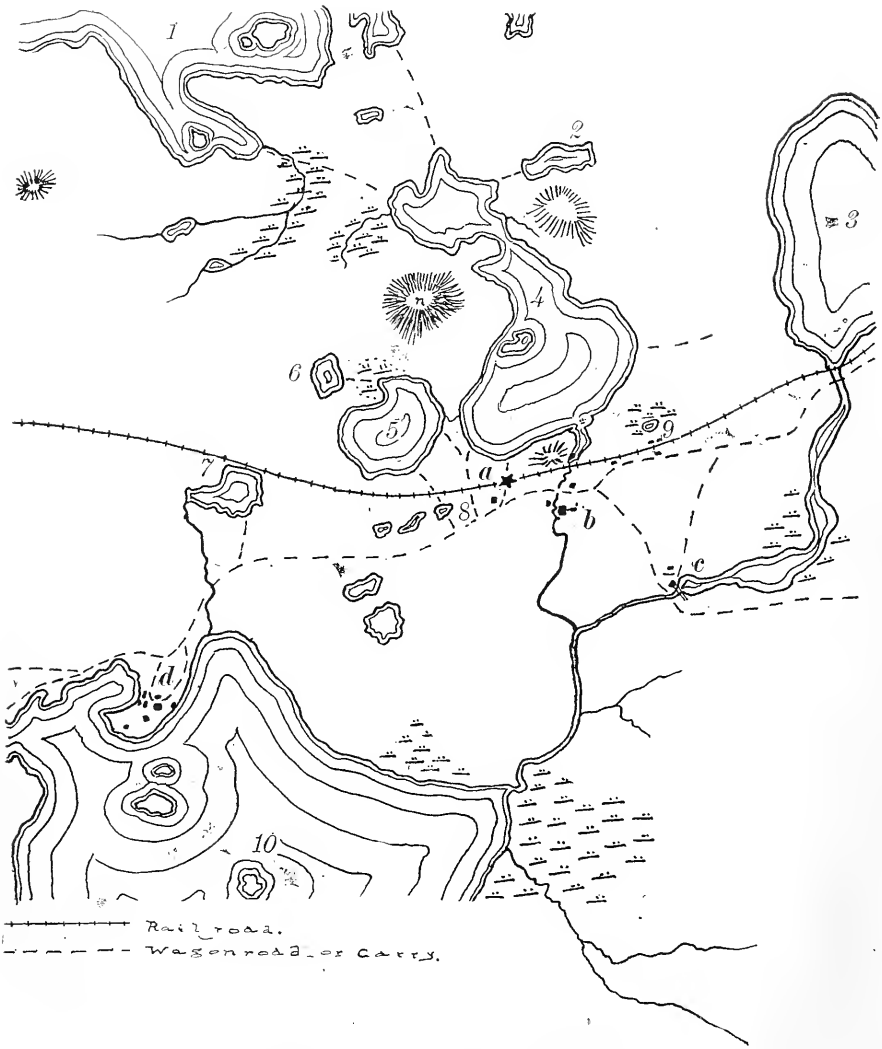


Map 1 Drainage map of the Saranac region

Lakes: 1 Raquette; 2 Long; 3 Tupper; 4 Ne-ha-sa-ne; 5 Cranberry; 6 Upper Saranac; 7 St Regis; 8 Rainbow; 9 Placid; 10 Schroon
Towns: *a* Malone; *b* Saranac Junction; *c* Saranac Lake; *d* Lake Placid: *e* Saranac Inn; *f* Tupper Lake *g* Axton; *h* Keene Valley
Mountains: *m* Whiteface; *n* Marcy (Tahawus); *o* Seward; *p* Boot Bay; *q* St Regis

Saranac Inn is very near the Champlain-Ontario divide, on a sandy, undulating mountain upland in the midst of almost unbroken forest. Round about it are numerous lakes, ponds, bogs and clear, slow flowing streams, with here and there a low ridge built on outcropping gneiss, or a sharply rising, densely wooded hill. There is more of sand and less of rock, more of water area and less of mountain, than in most places in the Adirondacks; and the descent of the streams is much more gentle.

The forests are composed, as elsewhere, mainly of hemlock and balsam, beech, yellow birch and maple, pine and spruce having been mainly removed by lumbering, and oaks and our common nut-bearing trees never having been present in the Adirondack woods. In the drier and denser parts of the woods, where there is little undergrowth, the hobblebush, Viburnum alnifolium Marsh., spreads its broad leaves on straggling branches to catch the scanty sunlight, while Indian pipe, Monotropa uniflora Linn., star flower, Trientalis americana Pursh, rattlesnake plantain, Peramium pubescens (Willd.) MacM., Indian cucumber root, Medeola virginiana Linn., the yellow Clintonia, Clintonia borealis Linn., the dwarf Smilacina. Vagnara trifolia (L.) Morong, several pretty species of ground pine, Lycopodium, and innumerable mushrooms spring from the loose leaf mold. Recently burned tracts are mainly in the possession of the bracken fern, Pteris aquilina Linn., the fireweed, Chamaenerion angustifolium (Linn.) Scop., poplars and wild cherry. In wet places in the woods occur stemless lady's slippers, Cypripedium acaule Ait., in the shadows, and in the openings grow cinnamon fern, Osmunda cinnamomea Linn., and clumps of the red elder berry, Sambucus pubens Mx., which in midsummer, when the fruit is scarlet, are strikingly beautiful. In the bogs the trees are balsam and tamarack in nearly clear patches; the shrubs are mainly Labrador tea, Ledum groenlandicum Oeder, small cranberry, Oxycoccus oxycoccus (Linn.) MacM., lambkill, Kalmia angustifolia Linn. and the pale laurel, Kalmia glauca Ait.; the herbs are mainly the universal sphagnum, the cotton grass, Eriophorum sp.?, the sundew, Drosera rotundifolia Linn., the swamp five-finger, Comarum palustre L., and a variety of orchids. The more strictly aquatic plants will be mentioned in connection with the situations in which they grew, and where studies were made of the insect fauna. But I should not omit to mention in passing that the exposed banks by every roadside were covered with mats of



Map 2 Saranac Inn and immediate vicinity

Lakes and ponds: 1 St Regis pond; 2 Grass pond; 3 Lake Clear; 4 Little Clear pond; 5 Little Green pond; 6 Bone pond; 7 Rat pond; 8 and 9 Little Bog ponds; 10 Upper Saranac Lake
Places: *a* Saranac Inn railroad station; *b* Adirondack hatchery; *c* the sawmill; *d* the Inn

mosses, mainly Polytrichium, and bunchberry, Cornus canadensis Linn., and the latter were very pretty, when covered with white bracts, as in June, or when covered with scarlet berries, as in August.

Propagating ponds. Since the three ponds reserved by the state for fish-propagating purposes were the scene of our principal field studies, a few words concerning their character may best be said here.

Bone pond is quite small, as our map will show, is hidden in deep woods, and is accessible only by a "carry" from Little Green. It has gently sloping banks round about, there being no outlet, the hemlocks of the woods come down near to the shore, and there is not the usual fringe of tamaracks outside the sphagnum moss which thinly fringes its banks, but the sphagnum is grown full of lambkill and other small heaths. The sphagnum ends in shallow water and is followed by a zone of sedge, Dulichium arundinaceum (L.) Britton, and manna grass, Panicularia sp.? In the deeper water, but not forming a continuous zone except for short distances, are stretches of yellow water lilies, Nymphaea advena Soland., and a species of bur reed with very long stem and leaves, the latter not rising from the surface, but lying flat and directed generally off shore, Sparganium simplex angustifolium (Mx.) Englm.? In the more open places along shore a species of pipewort, Eriocaulon septangulare Wither., was observed growing abundantly, and extending out into deeper water by a succession of stolons, which rooted readily to the white sand of the bottom. Among these lay loosely small masses of moss and filamentous algae. In such places the sieve net brought up from the bottom, where they were beyond view and almost beyond reach of the net, besides the pipewort, moss and algae, great quantities of empty caddis fly cases of the species described in the following account of that group by Mr Betten as no. 2, p. 572, and also the loose, flocculent cases of blood worms (larvae of gnats, Chironomidae); but the larvae of the gnats themselves were not found except in the stomachs of the brook trout which lived in this pond, and in these they were abundant. The burrowing nymphs of dragon flies, Gomphus, were also common here, where they burrow along under the thin layer of silt that covers the sand. They seemed to escape the trout. Among the sedges and grasses nearer shore other dragon fly nymphs and caddis fly larvae were also abundant.

This pond was farther from headquarters than were any of the other situations in which we planned field studies. We did not visit it till

August, and we went to it then only because it offered an exceptionally good opportunity for the study of the insect food of the brook trout.

Little Green pond is a beautiful sheet of water half a mile long and nearly as wide, with steeper banks that are nearly destitute of aquatic vegetation, excepting in the little bay on the north shore, and with a bottom of clean white sand. The vegetation of the bay is somewhat similar to that of Bone pond, with the addition of the white water lily, Castalia odorata (Dryand.) Woodv. & Wood. Wintergreen, Gaultheria procumbens Linn., and twin flower, Linnea borealis Linn., and the pretty little Dalibarda repens Linn., as well as big tufts of the lichen commonly known as "reindeer moss," occupy the dry and abruptly sloping south shore. Little Green is not a trout pond. Frequent plantings of fry have resulted in nothing. Little collecting was done there, for it seemed very barren of insect life.

Little Clear pond (pl. 1, 2) is nearly a mile and a half long, a mile wide, and is said to be in places more than a hundred feet deep. It is worthy of a more pretentious name. Owing to irregularities of contour, it has a very long shore line, that varies in character according to the inclination of the adjacent slopes. Conditions have been somewhat disturbed here within recent years by the building of a dam at its outlet, that has raised the water several feet, and caused it to encroach on the surrounding timber, which now stands dead along the shore. Aquatic shore vegetation is not abundant except in a few places. Two places were selected in Little Clear for more or less regular collecting, the bay in Blueberry island near the west shore, and the outlet.

Blueberry island is a small sandy spit of burned-over land, now covered with a thin growth of poplar trees, with broad mats of moss and lichen, with extensive clumps of blueberries, and with other clumps of Labrador tea overhanging its shores, specially in the bay. The banks are strewn with decaying trunks of fallen hemlocks, and in the narrow channel between the island and the hill to the westward dead trunks are still standing in water of considerable depth. The water is shallow for a little distance in the bay, and contains a sparing growth of aquatics, such as yellow and white water lilies, sedges, and cat-tails. Not a great many species of insects were collected from this bay, but some of these were exceedingly abundant; as, Chauliodes rastricornis, and species of Gomphus and of Tetragoneuria.

The outlet of Little Clear pond offered considerable variety of situation in small compass. Its east shore was strewn with logs so thickly as to be difficult of access with a boat except next the lake, where was a

low hummock of land covered with cat-tails. Behind this hummock was a shallow stretch of water in which we did some most profitable collecting. The bottom here had once been dry land, and was covered mainly with fragments of bark and twigs, but it was the home of numerous caddis fly larvae, particularly those with cases of stick chimney, or cobhouse type, and of the nymphs of the fine May fly, Siphlurus alternatus Say. The west shore of the outlet was more accessible; and, though collecting along it was not easy because of the abundance of brushwood to entangle a net, it yielded a great deal of most valuable material, particularly dragon fly nymphs. My only specimens of the nymphs of the two beautiful species, Cordulia shurtleffi Scudd. and Leucorhinia glacialis Hagen, were obtained along this shore in a sheltered place.

Through the outlet there flows an imperceptible current, which may be responsible for the presence of two interesting plants there which were not observed elsewhere, the water shield, Brasenia peltata Pursh, and shining river weed, Potamogeton lucens Linn. Of the latter there was a bed directly in the channel, and, passing over in a boat it was delightful to look down into the depths of the clear water, at the long graceful sprays of shining lutescent leaves. A species of bladder wort, Utricularia, was not uncommon in the shallow water behind the cat-tail hummock, and two species of shinleaf grew there at the shore, Pyrola secunda Linn. and P. elliptica Nutt.

Little Clear creek (pl. 3–6) will be discussed below in connection with the account of the special studies made of the life of its waters.

Bog ponds. Of the numerous small ponds in the vicinity of Saranac Inn, hidden in the woods and fringed with a typical floating border of bog moss, we collected extensively at but one—the one a quarter of a mile southwest of the station and south of the track—and visited but one other, about as far east of the station and north of the track. Of the former only I will speak here; the other was very similar.

This little pond (pl. 7) was a woodland gem. The picture of it presented herewith gives but a poor idea of it; for the fine coloration of fringing vegetation, of forest background, and of water and sky are necessarily absent from the picture. It was a peculiar place to collect in, being difficult of access, and very difficult to collect in when reached; but it was conveniently near at hand, and was peculiarly attractive on account of the many beautiful and interesting plants and insects found there Its vegetation (pl. 8) showed a beautiful zonal distribution. Farthest out

was the zone of the very abundant yellow water lilies. Next came a very broad zone of sphagnum, floating at its outer edge over water 5 feet or more in depth, with here and there a detached and floating island. This zone was fairly sprinkled over with pitcher plants, Sarracenia purpurea Linn., and with a succession of pretty orchids, Limodorum tuberosum L., Arethusa bulbosa Linn., Habenaria sp?, while a few clumps of lambkill and tufts of cotton grass were scattered about. Back of the sphagnum was a thin fringe of pale green tamaracks, while dark hemlocks of the forest stood close behind, and in the pools in their shadows nestled beds of native callas. Numerous fine dragon flies and a few large caddis flies and the handsome larva of some, to me unknown, diving beetle were the principal insects observed there.

Objects and results

This station, being located in the midst of a region whose aquatic insect fauna had scarcely been studied at all, offered a wide choice of field operations. Being established solely for the study of aquatic insects, and in this respect unique among field stations, it lacked the advantage accruing from the simultaneous study of other forms of aquatic life, but offered opportunity for concentration on some of the problems of aquatic entomology. The following objects were had in mind, though it was realized from the beginning that little would be done with some of them, and that any one of them might have been made to occupy our time profitably: 1) to increase the state museum collections; 2) to increase our knowledge of the aquatic insect fauna of the Adirondack region; 3) to study the place of aquatic insects in natural societies; 4) to study the reproductive capacity of insects; 5) to study the habits of aquatic insects; 6) to study the food relations of insects, fishes and other aquatic animals; 7) to study the life histories of aquatic insects.

Additions to the state museum. Our collections of specimens were so numerous that the attempt made at first to keep some record of the number and kind of specimens was early abandoned. When hundreds and even thousands of specimens were being collected every day, the enumeration of them would consume time that was greatly needed for matters of more importance. Miscellaneous collections were made by sweeping vegetation with a net, and by trap lanterns set at night when the rain ceased long enough to permit these operations, and the material thus obtained was sent while fresh to Albany to be prepared there for the cabinet. On warm, still, rainless nights the lanterns attracted from the surrounding woods a very large number and variety of moths, which have been preserved, but not studied as yet.

Special collections were made of aquatic insect species hitherto insufficiently known, of which not a few species known only from a few poor specimens appeared at Saranac Inn in great numbers; and we took occasion to gather good series of specimens of such, and also of a few new species which were no less abundant.

The most valuable collections were those of life history material. All that is described in part 3 of this report as coming from Saranac Inn has been added to the state museum; and so important is this material that future monographers in several groups will find it very desirable to consult the collections at Albany.

Aquatic insect fauna of the Adirondacks. All that has been written on this subject is comprised in a few short paragraphs in two papers by Dr Lintner,[1] in a few isolated descriptions of Adirondack species, like that of Simulium pictipes, from Ausable river, by Dr Hagen,[2] in a record by Dr Calvert[3] of a few dragon flies collected at Lake St Regis by J. Percy Moore in 1890, and at Keesville by W. Sheraton in 1894, and in rare locality references in other lists. The Adirondacks are not less interesting entomologically than the White mountains, which have been the resort of New England entomologists for half a century.

The following lists, while not even pretending an approximation to completeness (excepting, perhaps, the suborder Anisoptera of dragon flies) add a considerable number of species, not hitherto known to occur within our fauna; and also, a small number of interesting new species. Of these I have described three species and a variety under the following names: Leuctra tenella; Sisyra umbrata; Climacia dictyona; Gomphus descriptus var borealis.

I have also described the male of the interesting pygmy May fly, Baetis pygmaea Hagen, hitherto known from a fragment of a single female specimen, and the female of the beautiful dragon fly, Leucorhinia glacialis Hagen (pl. 10).

Mr D. W. Coquillet has described at my request two new genera and species of Diptera (*see* p. 585 and p. 586); and W. H. Ashmead has described five new species of parasitic Hymenoptera (*see* p. 586) and Mr A. D. MacGillivray, two new species of sawflies (*see* p. 585).

As the region about Saranac Inn differs considerably from most localities in the Adirondacks, as stated above, its insect fauna will doubtless

1 Lintner, J. A. Collections in the Adirondack region. 5th rep't N. Y. state entomologist, 1889. p. 231–86.

——— 10th rep't p. 376–77.

2 Hagen, H. A. A new species of Simulium with a remarkable pupa case [Simullum pictipes]. Bost. soc. nat. hist. Proc. 1879. 20:305–7.

3 Calvert, P. P. Odonata of New York state. N. Y. ent. soc. Jour. 1895. 3:39–48. Additions, 1897. 5:91–95.

be found likewise to differ. It has an abundance of dragon flies and caddis flies and of certain Diptera, while certain other groups, notably the stone flies, which require more rapid and rocky streams, are not well represented.

Place of insects in natural societies. A very little was done by us in the study of this subject, but that little constitutes part 2 of the present report.

Reproductive capacity of insects. But one thing was attempted under this head, and that was the determination of the number of eggs laid by individuals of a number of species, by means of the examination of the ovaries of newly transformed females. This undertaking at once revealed some interesting biologic facts, which might, perhaps, have been inferred in advance, and which may be known, though I have not read of them. These may be stated as follows.

1 In certain insects (as May flies, caddis flies, gnats, etc.) which lack functional mouth parts, and whose adult life is very brief, the eggs are well developed at transformation, and may readily be counted, the difference in size between the developed eggs and the egg rudiments which will not develop being very marked.

2 In other insects (such as the larger dragon flies) the eggs are very immature at transformation, and it is impossible to determine how many of the egg rudiments present at that time will develop into eggs. In other words, the time of the maturing of the eggs is related to the duration of the adult life, and to the amount of food taken during adult life.

Having read that the larger dragon flies of the gomphine group live as imagos but a week, I was surprised to find that the eggs of a newly transformed female of Hagenius brevistylus were so immature as to be scarcely recognizable; but I have since observed that there is in this and in many other large gomphine species an interval of about a month between the period of transformation and that of oviposition. I am inclined to think that the dragon flies which have been kept successfully only a week in confinement have died of starvation, and that in any case the length of imaginal life is not fairly determined so.

The few counts successfully made by us from insect ovaries will be found under the discussion of the species on which they were made.

Study of the habits of insects. What animals do has always been an interesting subject of inquiry, and probably will always be so. A knowledge of the habits of animals has its own peculiar culture value, now generally recognized. It has a higher scientific value,

also, than specialists have always been willing to admit. It has a paramount economic value also, for it forms the basis of nearly all intelligent economic procedure. We do not yet know how the teeming aquatic life of our streams and lakes and ponds may be manipulated as terrestrial life is manipulated to serve human needs, but this we may learn in due time, and, when we have learned it, the accurate knowledge of the habits of aquatic species of insects will be as necessary then as such knowledge of economic terrestrial species is now.

The following pages contain new observations on the habits of many species — occasionally on groups of species. These will be found under the accounts of the groups and the species in part 3 of this report.

Food relations of insects and fishes. It was planned from the beginning that we should study fish food, if the opportunity offered for making a real contribution to the present knowledge of that subject. When, through the courtesy of the state fish commission, we were given working quarters in the Adirondack hatchery, we were the more desirous of attacking some of the problems which scientific fish culture needs to have solved; what problems, it was at first a little difficult to decide.

In the culture of all animals there are two principal objects to be sought: 1) protection for the young, and 2) forage. Past triumphs of fish culture have come from the mastery of the difficulties in securing the first of these, the second has scarcely been seriously undertaken. While extensive food studies have been made by Prof. Forbes and a number of others, from which we have learned in general terms what fishes eat, still there is hardly a fish of which we may say we know what species it eats, at what age, at what season, in what situations, with what choice of food. And so little are the essential features of good foraging ground understood that each planting of fry in a new place is still largely an experiment.

So it seemed to me that any new study of fish food should include the study of the feeding grounds, feeding habits, choice of food offered, and conditions that make for the continuance and possible increase of the food supply. The two smaller propagating ponds at Saranac Inn, Bone and Little Green seemed to offer an excellent opportunity for contrasting conditions relative to these points. Bone pond has been well stocked with brook trout for some years, while Little Green, after numerous annual plantings, has remained as barren of trout as ever.

Through the earlier part of the season some random collections of food were made from trout caught in gill nets set for suckers; but not till August was there opportunity to make the studies outlined above, and

then our efforts met with interference which made their successful prosecution impossible. Before they were abandoned, however, the stomachs of some 27 brook trout were obtained, and their contents (consisting almost wholly of insects), cleaned and preserved, are now part of the state museum collection. The records of the numerous insects collected during these few days about the shores of Bone pond will be found under their respective species in part 3 of this report, and a brief account of the vegetation, above in the introduction. A random report on the fish food there collected may yet be made from the material I prepared, but it will of necessity lack the features which I counted most essential, unless farther study be made at the pond itself.

Bullfrogs were common in Little Clear creek, and I collected the stomach contents of 25 of them. Lack of time is the only reason why they have not been studied, and are not reported on at the present time.

Life histories of insects. One of the first decisions made with respect to station work was that no greater service could be done for aquatic entomology, pure or applied, than adding as opportunity offered to present knowledge of insect life histories. So long as the species can not be recognized in their immature stages, little progress is possible in food studies, or in quantitative studies of any sort. To this absolutely necessary preliminary work, therefore, much the greater part of our time was given.

We were able to work out more or less completely the life histories of about a hundred species of aquatic insects, immature stages of most of which are described in part 3 of this report. Those who have done life history work will not need to be told that this work occupied rather fully the available time of our short session.

In order to make part 3 serviceable to teachers and students, I have filled it with keys and tables for determining the orders, families, genera and species of immature stages of aquatic insects, and have illustrated these with special figures explaining the terms used. The several orders will be found to have received very unequal treatment, because we wished to add chiefly to the knowledge of the things least known. For this reason the larvae of Diptera and Coleoptera received much less than a fair share of attention; for they are already much better known than are the larvae of the other orders treated.

More dragon flies than anything else were reared. There are two reasons for this: Saranac Inn is a splendid locality for dragon flies, and I have been rearing dragon flies for a number of years and have learned how to do it. With slight additions from my former breedings, I have

been able to give in part 3 an account of the dragon flies (suborder Anisoptera of Odonata) which is almost a monograph of the New York species of that group.

But two species of stone flies were seen at Saranac Inn. Both of these were reared, and the descriptions of their nymphs, published herewith, appear to be the first to be printed for American species.

I have been able to rear representatives of all the New York genera of May flies, and present in part 3 a key for the determination of the nymphs of the same—apparently the first key to be published for American forms.

In the Neuroptera, with its two families having aquatic genera, I have been able to straighten out a tangle in the Sialidae, and to report the discovery of larvae and pupae of two genera of Hemerobiidae. These two are both new species of spongilla flies, representing two genera whose larvae live on fresh-water sponges. Entomologically, their discovery was one of the best things of the season. Our account of the aquatic Neuroptera is thus considerably more complete than any that have hitherto appeared.

Mr Betten occupied himself during the intervals of routine operations with the study of the habits and transformations of the caddis flies. He has written the account of this order in part 3. He collected many specimens in all stages, and reared four species representing as many genera. His descriptions seem to be the first that have appeared for American larvae. It is a matter of regret that specific determinations could not be had for more of the material in this little studied group. He has prepared a table for caddis fly larvae, compiled from the descriptions of European writers and verified, so far as possible, on his own material, and while it is tentative and incomplete, it will doubtless serve a temporary purpose.

Aquatic larvae of flies and beetles were abundant at Saranac Inn, but there was little time available for their study after attending to the others mentioned above. A few of the more interesting ones were reared, however, and will be found described in part 3. The three bred Diptera there described make an interesting addition to our knowledge of the larvae of that order.

Apparatus and methods. Little need be said on this head. We used the insect nets, cyanid bottles, setting boards, pins, and preservatives used by all collectors; but our main stay in aquatic collecting was the sieve net[1], which is shown in use in plate 4; leaning against a tree in

1 Described and figured in part O of U. S. nat. mus. Bul. 39, p. 4.

plate 5. On the sandy bottoms of these quiet waters it was specially advantageous. Extensive use was made of white wash bowls, soup plates and saucers in the examination of our catch. We habitually placed teneral specimens of most orders, when found in the cages newly transformed, in paper bags to await the maturing of their colors.

For rearing purposes, the screen cage, a simple cylinder of wire screen with a loose cover (described on page 7 of the above mentioned bulletin and shown in operation in plate 5) was most useful. The larger cages of this sort were set down in the sand of the bottom of the creek; smaller ones were set in the hatchery troughs. These, of course, needed a bottom, which was supplied by inserting a piece of cloth laid over an open loop of spring wire; the wire when released holding the cloth tightly against the sides of the cage. A still farther modification of this cage consisted in making it smaller, and of fine brass screen, and attaching cork to its sides to float it. Mr Betten made a very good egg-hatching cage out of it by sealing a watch glass in the bottom of it with paraffin, and attaching the cork floats. The eggs were thus kept in flowing water, but could be at once removed to the stage of the microscope without disturbance.

I devised for our work at Saranac Inn another type of floating cage that proved so generally useful for minute insects, and was so easily and rapidly constructed that it may be worth while to give a description of it. The accompanying figure shows its construction in the main. With the five little pieces of wood (which should be cut from dry pine) at hand, a cage of this sort can be put up and ready for use in 10 minutes. The cloth is attached to the wood by means of paraffin. which is melted and applied with a brush. The loose end of the cloth is attached, and the door closed by means of a rubber band stretched between two tack heads over the convex upper edge of one of the wooden side strips (fig. 1). This sort of cage was most successful with small Diptera, but not with small May flies, such as Caenis; for these would invariably fall into the water and die at once on transformation.

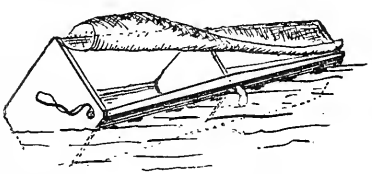


Fig. 1 Floating cage, designed for rearing small Diptera

Fig 2 A homemade cage which can be used successfully for rearing insects that live in standing water. Wooden kit with covering of netting tied on

The trap lanterns we used (pl. 4, 5) were also very simply constructed. The idea of them, however, was borrowed from some lanterns I found my

friend, Dr Westcott, using. The lantern part is of the "search light" type to be found on the market, with large parabolic reflector having projecting edges. The trap part consists of a circular flaring band of tin, whose slope continues that of the edges of the reflector, inside which it is pushed and fastened. It has two transversely placed sheets of wire screen within it, arranged as shown in the accompanying figure, and on the lower side within the trap there is an open, detachable cup to hold the cyanid of potassium. It is easily managed and very effective, and the specimens are in the main obtained in good condition. The lantern of the markets has many advantages in the way of conveniences over lanterns of home construction.

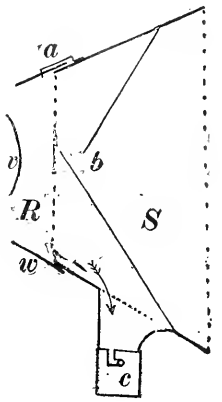


Fig. 3 Sectional diagram of lantern trap
R, edge of lantern
v the globe
w edge of parabolic reflector
S, the trap
a catch for attachment to reflector
b the entrance between two sheets of screen
c detachable cyanid cup

Assistance in preparing this report. At the conclusion of my work at Saranac Inn, I went to Cambridge Mass., where, through the courtesy of Mr Samuel Henshaw, I was allowed to spend several weeks determining the specimens I had collected, by comparison with specimens in the museum of comparative zoology. During this time Mr Henshaw showed me many kindnesses and took the trouble himself to determine the names of a number of species. I am also under special obligation to Mr D. W. Coquillett and Mr William H. Ashmead, of the U. S. national museum, for the study and determination of numerous Diptera and Hymenoptera respectively, and for the descriptions of new species sent me by them to be published as a part of this report. I am indebted, also, for determinations, to a number of other gentlemen, as follows: Trichoptera, Nathan Banks; Orthoptera, Dr S. H. Scudder; Homoptera, Prof. Herbert Osborn; leeches, Dr W. E. Castle and Dr J. Percy Moore; mollusks, Frank C. Baker; an entomostracan, Prof. E. A. Birge.

The colored plates have been made by L. H. Joutel. The figures of Trichoptera are by Mrs J. H. Comstock. Those of Diptera, Plecoptera and Ephemerida are by Miss Maude H. Anthony. Those of Odonata are drawn by myself. The figures made from photographs taken by other persons than myself, contain the proper acknowledgment in their legends.

Part 2

LIFE OF LITTLE CLEAR CREEK

This tranquil little stream (pl. 3), once famous for its trout fishing, traverses the hatchery grounds, and disappears in the woods below under a canopy of overarching alders. It leaves the pond at present by a little artificial fall, runs through a big, tubular iron culvert under the railroad, tumbling over a little bed of stones at the end of the culvert, and then traverses a narrow bit of brookside meadow, bordered by spring bog full of balsam trees. Then it enters the fish ponds. Passing the hatchery, and all the fish gates, it is free again for a little open space before entering the woods below. From the pond to the woods below the hatchery is less than a quarter of a mile; and in this short space the following studies were made.

In the undisturbed portion of this course the brook glides alternately over beds of rippled reddish sand or percolates through tangled mats of river weed, Potamogeton, and stonework, Nitella, or clumps of bur reed, Sparganium. It has an average depth of perhaps a foot, and a width of about 10 feet. Its depth varies very little with the weather, a continuous downpour of rain for days raising its level but a few inches.

In the edges of the woods were seen scattering stemless lady's slippers, and banks of that dainty little favorite of Linnaeus, the twin flower, while the star flower and the bunchberry and the yellow Clintonia and the red elder berry made these places bright in June with their flowers and in August with their brilliantly colored fruit.

From this little strip of water we did more or less collecting every day of the session. While we thus gained some general information as to what the stream contained, we were desirous of making our knowledge more exact by quantitative studies, for which unfortunately our breedings, requiring constant attention, left us very little time. We did, however, make quantitative studies of the animal life of two little patches of the creek, made a count of the cast skins of dragon flies left along a strip of the bank, made qualitative studies of the insect life of the ripple below the bridge, and of the hatchery pipes and troughs, and made some scattering observations of more or less interest, which will constitute the subject of this chapter.

Quantitative studies. These were made from two patches of Little Clear creek, each approximately 15 square feet in surface area. They do not include the animals that slipped through our nets, the

coarsest of which had a mesh of about 2.5 mm square (10 meshes to the inch). The method was the same for both: the plot was staked out; the vegetation was swept with an air net down to the water line for its aerial forms of life; it was swept again with a water net for its aquatic population; it was then pulled up by the roots and piled in pails and examined a handful at a time in a bowl of clean water, having all the animal life separated from it; the soil of the bottom was then scraped up and sifted for a depth of two or three inches. The material was very quickly gathered up from the plot selected, but the separation of the animal life from the plants and débris was a whole day's work for two or three persons, to say nothing of the time necessary for studying the animals later. These studies, though time-consuming, always yielded the information sought as to the relative numbers of the several species present, and were profitable, also, in quite another way. The careful examination of the situation which they necessitated always revealed the presence of a number of species not found by more superficial collecting methods, and these were not always the smaller species.

First plot. This was in the creek just below the hatchery. The site is shown in plates 4 and 5. The plot extended from the edge of the current in open water 12 to 15 inches in depth, to the bank, a distance of about 5 feet, and a strip 3 feet wide was selected. Two views of it from opposite sides are given in the plates, and its exact site is indicated by the position of the sieve net in plate 4, and is occupied by the cage in the foreground in plate 5. The collections were made July 10. The water was about 3 inches deep at the bank, and descended somewhat regularly toward the current side. Over nearly the whole of the area there was an abundant growth of aquatics, most abundant among which was a species of matted, submerged Potamogeton, intermixed with a variety of filamentous algae, and a little Nitella. The plants which appeared above the water were water-cress, water-speedwell, and a thin grass which I took to be a species of Leersia. There was no bur reed growing in this plot.

The following animals were taken from this plot.

Vertebrates

1 full-grown bullfrog, Rana Catesbiana Shaw, whose stomach contained: 7 full-grown snails, Physa heterostropha Say; 1 dragon fly, ♀ Calopteryx maculata Beauv.; 1 Crane fly (undetermined); 1 Scarabaeid beetle; 1 female winged carpenter ant; 1 Syrphus fly (apparently one of the smaller members of the genus Syrphus); 1

caddis fly (teneral imago; undeterminable); 1 water skater, Hygrotrechus sp.?, and fragments of a number of others; 1 small bullfrog tadpole; considerable sand intermixed with fragments of Potamogeton leaves; 1 Entomostracan (undetermined)

3 grown bullfrog tadpoles

1 young green frog, Rana clamata Daud. The stomachs of the tadpoles and of this frog were empty

1 small salamander, probably an Amblystoma

1 long-eared sunfish, Lepomis auritus Linn., whose stomach contained: 34 little snails, the largest not over 1.5 mm long, apparently of the genera Physa and Limnaea; 12 larvae of gnats (Chironomidae), 2 Chironomus sp.? and 10 Ceratopogon sp.?; 1 larva of Chauliodes sp.? in fragments

Mollusks

305 snails, retained by our nets, not counting innumerable smaller ones, which fairly covered some of the plants. The 305 were:

292 Physa heterostropha Say

13 Limnaea desidiosa Say

35 small clams, Sphaerium similis Say

Leeches

6 specimens 2-4 inches long of Haemopis (Semiscolex) grandis Verrill

A large number of minute glossiphonids, the counting of which was not undertaken

Insects

The following were taken with a sweeping net from above the surface of the water

DRAGON FLIES

1 Aeschna sp.?, probably constricta Say, found transforming

1 Ischnura verticalis Say ♀

1 Lestes unguiculata Hagen ♂

2 Argia violacea Hagen ♂ and ♀

1 Nehallennia irene Hagen ♀

BUGS

43 water skaters, Hygrotrechus sp.? (A greater number got away)

2 Helochara communis Fitch

20 Cicadula sexnotata Fall

1 C. divisa Uhler

7 Liburnia pellucida Fabr., of which two were females, one macropterous, and one micropterous

1 Chermes sp.? (apterous)

3 Aphids (undetermined)

1 Lygaeid (undetermined)

FLIES, AND OTHER DIPTERA

65 Hydrellia scapularis Loew. A number of other little Muscidae, some of them apparently of different species, escaped

1 crane fly ♀ (undetermined)

1 mosquito ♀ (undetermined)

3 gnats of three species (undetermined)

MISCELLANEOUS

1 Psocid, Peripsocus madidus Hagen

1 Anthicid beetle, Notoxus anchora Hentz

8 parasitic Hymenoptera: Telenomus longicornis Ashm.[1] 1 ♂; Brachystropha quadriceps Ashm.[1] 1 ♂; Rhizarcha astigma Ashm.[1] 1 ♂, 3 ♀s; Aphidius nigripes Ashm.[1] 2 ♂s

The following insects were taken from the water.

DRAGON FLY NYMPHS

4 Aeschna constricta Say of various sizes, one full-grown

7 Cordulegaster maculatus Selys

3 Gomphus scudderi Selys

6 Gomphus spicatus Hagen

2 Ophiogomphus aspersus Morse

2 Basiaeschna janata Say

2 Sympetrum assimilatum Uhler

MAY FLY NYMPHS

2 Hexagenia variabilis Etn.

5 Ephemera varia Etn.

3 Ephemerella excrucians Walsh

5 Caenis diminuta Walker. These nymphs are so hard to find among the stems to which they cling very closely, that more were probably present but not seen.

[1] Described on p. 586–88.

CADDIS FLY LARVAE AND PUPAE

15 Molanna cinerea Hagen
8 Polycentropus lucidus Hagen
2 Halesus no. 1 (*see* p. 567)
2 Halesus no. 2 (*see* p. 568)
3 Halesus no. 3 (*see* p. 569)
13 unclassified . . . 43 in all

DIPTEROUS LARVAE AND PUPAE

3 Sepedon fuscipennis Loew
1 Bittacomorpha clavipes pupa, probably from the farthest point in shore
7 Simulium venustum Say
8 Tabanid larvae (undetermined) from the bottom in the edge of the channel in open water
1 crane fly pupa (undetermined)
107 gnat larvae (Chironomidae: all undetermined) of four species
Numerous minute Ceratopogon? larvae were observed in the algae associated with still more numerous Limnicolous oligochaetes.

Second plot. The second plot selected for study was in the upper part of the hatchery grounds, just below the railroad bridge. It was a strip across a bed of bur reeds (shown in the foreground of plate 3) and was similar in form and about equal in area to the preceding. Collections were made precisely as before, but the conditions in the plot were somewhat different; the water was of about the same depth, but there was more of a current flowing through the bur reeds. Potamogeton and Nitella and filamentous algae were perhaps a little less abundant in the water here, specially the algae. The date was July 27.

The list for this second plot is a short one, in species, if not in individuals. It is as follows:

1 bullfrog, Rana catesbiana Shaw
1 crawfish (undetermined)

MOLLUSKS

13 snails: 11 Campeloma decisum Say; 2 Limnaea desidiosa Say
245 clams, mainly Sphaerium simile Say

117 CADDIS FLIES

27 Molanna cinerea Hagen
22 Hydropsyche sp.? (near phalerata) Hagen (*see* p. 566)

17 Polycentropus lucidus Hagen
8 Halesus no. 1 (*see* p. 567)
10 Halesus no. 2 (*see* p. 568)
16 Halesus no. 3 (*see* p. 569)
17 unclassified

260 BEETLES

Donacia emarginata Kirby, of which two were adults, 152 were inclosed in puparia attached to the bur reed roots, and a few were free larvae. Since several species occurred about the creek, it is by no means certain that all these belonged to the single species named.

25 DRAGON FLY NYMPHS

2 Cordulegaster maculatus Selys
4 Aeschna constricta Say
4 Gomphus exilis Selys
5 Ophiogomphus aspersus Morse
5 Argia violacea Hagen
5 Sympetrum assimilatum Uhler. Of this species 7 additional specimens were picked from the stems above the water in transformation; but one other insect specimen (a stone fly, Leuctra tenella) was found above the water.

10 MAY FLY NYMPHS

1 Ephemera varia Etn.
4 Ephemerella excrucians Walsh
5 Baetis pygmaea Hagen

8 DIPTEROUS LARVAE AND PUPAE

2 small crane fly larvae (undetermined Tipulidae)
4 horsefly larvae (undetermined Tabanidae)
2 mosquito pupae (undetermined)

Comparing now the lists made from the two plots we observe some striking differences. Those that appear in the number and variety of aerial forms taken in the first plot, and the paucity of them in the second, may be due mainly to weather conditions: the first plot was worked on a dry, sunshiny morning; the second, on a partly cloudy morning after rain. The plots agree in that their miscellaneous plant feeders were mainly mollusks and caddis flies. Mollusks seem to constitute a larger bulk than any other single group. Snails were found in the stomachs of frog and fish, and are known to be the food of horsefly larvae (Tabanidae). There are certainly snails enough in the creek to justify the extraordinary abundance of horseflies in this vicinity.

The plots were strikingly unlike in that there were fewer species in the second, fewer dragon fly and May fly nymphs and dipterous larvae. They differed farther most strikingly in the kind of mollusks present: the Campeloma decisum of the second plot was absent from the first; it is common in the pond above. The long-horned leaf beetles, Donacia, of the second plot were a special feature which belonged with the special habitat furnished by the bur reed growth. Two photographs, reproduced in plate 9, show these insects in their natural positions on the plant.

These are fragments—mere fragments—of real knowledge of the life of this stream. While not without interest in themselves, they seem to me chiefly valuable in their suggestiveness of possible knowledge to be gained by farther application of these methods.

Count of dragon fly exuviae. In the midst of the hatchery grounds there was a fish pond, made by impounding the creek, with its eastern side boarded up to a hight of 15 to 20 inches above the level of the water, for a distance of perhaps 20 yards. The boards were rough, and suited dragon fly nymphs very well as a place to transform. It was an exceptionally favorable place in which to learn something of the numbers of dragon flies to emerge from a given water area; for the cast skins were all left in plain view. The other bank was not boarded, and while the cast skins appeared to be about as common there, one could not be sure of finding all of them. A view of this pond, looking up stream, is presented in plate 6.

Conditions here were right for determining the yield of this strip of water in dragon flies of those species whose period of transformation falls entirely within the last three weeks of June at Saranac Inn. I do not say half the yield, because it seems fair to presume that half were on the other bank, where their discovery was not so easy. Nymphs when ready to transform are blind, and wander about till they find a bank, showing no preference as to which bank it is. These time limits are taken because they are the only narrow ones that will include the entire transformation period of a considerable number of species.

I found quite a number of these skins already clinging to the boards on my arrival June 12, for the season for transformation for some of these species was already at hand. It appears fair to assume, however, that I obtained practically all the skins that had been left there, because they had apparently not been disturbed at all; they stick very tightly, so that moderate winds and even rain do not quickly dislodge them. The weather previous to my arrival had been clear and calm, and the season of trans-

formation was certainly only opening. I collected all that appeared after that daily till the end of June, at which time all the species for which I thought such counting practicable had ceased transforming for the year. The results of the count are as follows.

82 Gomphus exilis *Selys*
20 Gomphus brevis *Selys*
18 Gomphus spicatus *Selys*
24 Ophiogomphus aspersus *Morse*
11 Hagenius brevistylus *Selys*
7 Cordulegaster maculatus *Selys*
1 Didymops transversa *Say*
1 Tetragoneuria semiaqua *Burm.*
6 Basiaeschna janata *Say*

Intermingled with these were the cast skins of a number of species whose period of transformation was not finished, perhaps, by the end of the month of June; viz Calopteryx maculata Beauv. (12), Argia violacea Hagen (20), Enallagma sp.? (5), Boyeria vinosa Say (3), and Aeschna constricta Say (2).

It is difficult to conceive how so many of the large rapacious Gomphine nymphs can get a living in so small space. I do not believe that, judging by repeated collecting, they were more abundant here than in other basins along the creek. I collected in this same place with a sieve net after this count was ended the nymphs of the next season's brood, and obtained in 15 minutes' use of the net 22 Cordulegaster maculatus, 2 Hagenius brevistylus, 40 Gomphus and Ophiogomphus, 8 Calopteryx maculata and 4 Didymops transversa.

The life of the rapids. At the railroad Little Clear creek pours out of the culvert and tumbles over a little bed of stones. This is the only rapids within easy reach from the hatchery. There was no time for a quantitative study of its life, but we studied it as carefully as time would permit.

The most abundant and important animal in the rapids is the black fly, Simulium venustum Say. With the exception of a few Chironomidae which live in the "skin algae", covering the broader surfaces over which the water glides, all the life of the rapids seems to center in the Simulium colonies. These are very extensive indeed, masses of the swaying, dark greenish larvae, or of the yellowish pupae covering the stones over considerable areas.

Plate 15 shows the forms which I found together in this little rapids by the railroad. Simulium is vastly more numerous in individuals than all the other species put together and also more restricted in its habitat. The next in numerical importance would probably be the pygmy May fly, Baetis pygmaea Hagen, though a larger May fly, Heptagenia pulchella Walsh, and a caddis fly, Hydropsyche sp.? (see p. 566) seemed almost as numerous. These three species are probably predatory, feeding on the members of the Simulium colony. The other members of this little society are much fewer. They are 1) a hitherto unknown fly of the family Empididae, Roederiodes juncta Coq., (described post at p. 586) whose larvae crawl about among the Simulium pupa cases, and pupate within empty cases, and 2) the stone fly, Leuctra tenella.

It must be another, earlier species of black fly which makes all the trouble in the Adirondacks with its bites; for this one is quite peaceably disposed. Guides have a saying, that, when the black flies put on their white stockings in June, the trouble is about over. This species has the "white stockings."

I was interested in watching the females of this species ovipositing, and saw the operation very frequently. The place selected is always at the edge of a little waterfall, on a surface that is intermittently washed by the swaying current, and so kept wet (*see* pl. 15). Here the females flock, and pile up great white masses of eggs, which with a little age turn yellowish. Waves dash over them while ovipositing, and often sweep them away, but they at once return to their task.

I do not know what Simulium larvae feed on; but their tentacles seem well adapted for straining plankton from the water that dashes over them.

The life of the hatchery pipes and troughs. The life of the pipes is essentially that of the rapids.[1] What is living in the pipes is learned by observing what comes out of them, into the hatchery troughs and into the windows. Simulium, Hydropsyche, Heptagenia and Baetis, were in the hatchery windows throughout the session, often in enormous numbers. Their periods of greatest abundance do not coincide however. The windows were fairly darkened with black flies and caddis flies and the larger May flies, Heptagenia, during the earlier part of the session, while the pygmy May flies did not appear in swarming numbers till the latter part of it. The only member of the Simulium society as portrayed in the plate, which was not observed

1 It appears that the mollusks which get into city water pipes and sometimes cause trouble are forms that normally live in rapids.

to come into the hatchery was the fly, Roederiodes juncta. In addition to these forms, and the green stone fly, Chloroperla bilineata Say, which doubtless belongs with them in its season, there occurred in the hatchery a large number of Diptera of various sorts, and the spongilla flies, hitherto accounted so rare. Fresh-water sponges from the lake above invade the pipes, and the larvae of these flies come in with the sponges on which they live.

On June 19 we collected the contents of one of the supply troughs in the hatchery. It contained more than 125 little fresh-water sponges, averaging the size of peas, from which were picked seven spongilla fly larvae, nine amphipods (undetermined), one entomostracan, Epischura lacustris Forbes, about a dozen each of two species of May flies, Heptagenia pulchella Walsh and Ephemerella excrucians Walsh, a large number of black fly larvae, a few Hydropsyche larvae, a few gnat larvae and a number of colonies of rotifers.

Some of the multitudinous gnats in the windows were of the same species that I bred from larvae taken from "skin algae" scraped from the races outside. Horseflies (Tabanidae) were also conspicuous occupants of the windows, but I did not find their immature stages in the hatchery. Possibly these may have come in through open doors and windows, being so active and so abundant outside. The handsome longicorn beetle, Leptura canadensis Fabr., which was not uncommon in the windows during the latter half of the session, certainly entered in this way.

A small number of specimens representing a new genus and species of Stratiomyiidae (described in part 3, p. 585 as Zabrachia polita Coq.) were picked from the hatchery ceiling, while gathering spongilla flies.

Red hydras were exceedingly abundant in Little Clear creek during the first half of our session, insomuch that they fairly covered every trailing stem and leaf in the current, and occupied every available support, even to the backs of the dragon fly and May fly nymphs, one of which would often bear half a dozen or more of them. Then they gradually disappeared, till in August hardly a hydra was to be found. A single blade of Sparganium brought in in June for some eggs of Basiaeschna janata which had been laid in it, bore hundreds of hydras profusely budding, and all of a very distinct red color. An observant employee of the hatchery, Milo Otis, who attends to feeding the fry, informed me that at certain times the water flowing through the ponds is tinged with red from the hydras floating in it, and that at such times the young trout subsist on these, and refuse to eat other food. It would be interesting to

know whether this abundance of hydras always occurs when the trout are newly hatched.

Two fine Diptera belong to the characteristic fauna of Little Clear creek, but do not live in any of the situations we have been discussing. These are the curious phantom fly, Bittacomorpha clavipes Fabr., and our largest crane fly, Tipula abdominalis Say. Both live almost out of the water in very shallow bays filled with red-rotted vegetation and both are very common in such places.

Gomphus scudderi Selys was common in the creek below the wagon bridge, but was not taken above it.

Part 3

INSECT LIFE HISTORIES

In the following pages there is assumed on the part of the reader such a knowledge of the external parts of insects as is obtainable from the elementary textbook of entomology or of zoology. He should know that the body of an insect larva is composed of successive rings or joints; that the first division is the head and bears the eyes, antennae and mouth parts; the next three joints, bearing the wing and leg rudiments, constitute the thorax; and the remaining joints, often with prop-legs or prolegs under them, constitute the abdomen. External gills are arranged in delicate whitish tufts when in a sheltered position, or, when exposed, are thin plates traversed by delicate air tubes. In addition to these, there are at the sides of the abdomen, longer, paired, simple, pointed appendages, called lateral filaments, which also, when small and delicate, may serve the respiratory function. Lateral filaments, gills (with very few exceptions) and prolegs disappear with the end of larval life, and are absent in the adult insect.

In the immature stages insects differ wonderfully; but there are two types of larvae, which have been distinguished by the degree of difference between larva and adult insect: 1) those called nymphs, which differ but little from the adults in general organization, and when grown transform directly to imagos, without having entered on a quiescent pupal stage; and 2) larvae proper, which differ very greatly from their imagos, having the adult appendages reduced in size or altogether wanting, wings never visible externally, and requiring a quiescent pupal stage, when they have done feeding, before transforming to the imago. These two groups constitute the primary divisions of the table given below. The student will find in Comstock's *Manual for the study of insects*, or in his *Insect life*, or in a number of other books that are not so

good as these, serviceable tables for the determination of the adult insects. We give here a table that will serve for distinguishing the orders in the larval stage. So few relatively of the larvae of aquatic insects are known as yet, that this table must be considered tentative as to its statements of group characters.

In all the following tables and descriptions the characters described and the measurements given apply to fully grown nymphs or larvae except when otherwise expressly stated.

KEY TO ORDERS OF AQUATIC INSECT LARVAE[1]

a Larvae with wings developing externally (called *nymphs* in this paper) and no quiescent pupal stage

b With biting mouth parts

c With long, filamentous caudal setae; labium not longer than the head, and not folded on itself like a hinge

d Gills mainly under the thorax; tarsal claws two; caudal setae generally two.....(stone flies) Plecoptera

dd Gills mainly on the sides of the abdomen; tarsal claws single; caudal setae generally three.....(May flies) Ephemerida

cc Caudal setae represented by three broad, leaflike respiratory plates traversed by tracheae, or by small spinous appendages; labium much longer than the head when extended; at rest, folded on itself like a hinge and extending between the bases of the fore legs (dragon flies and damsel flies) Odonata

bb Mouth parts combined into a jointed beak, which is directed beneath the head backward between the fore legs.....Hemiptera

aa *Larvae proper*, with wings developing internally, and invisible till the assumption of a quiescent pupal stage

b With jointed thoracic legs

c With slender, decurved, piercing mouth parts, half as long as the body; small larvae, living on fresh-water sponges. Family Hemerobiidae of Neuroptera

cc With biting mouth parts

d With a pair of prolegs on the last segment only (except in Sialis, plate 29, which has a single long median tail-like process at the end of the abdomen) these directed backward, and armed each with one or two strong hooks or claws

e Abdominal segments each with a pair of long, lateral filaments Family Sialidae of Neuroptera

ee Abdominal segments without long, muscular, lateral filaments, often with minute gill filaments; cylindric larvae, generally living in portable cases.....(caddis flies) Trichoptera

[1] The Thysanura, or springtails, common on the surface of water, but not living in it are not included in this table. They will be readily recognizable, if collected, by their very minute size, entire absence of wings, mouth parts retracted within the head, and the forked spring beneath the abdomen.

dd Prolegs, when present, on more than one abdominal segment; if present on the last segment, then not armed with single or double claws; often entirely wanting

e With five pairs of prolegs, and with no spiracles at the apex of the abdomen ..... (moths) Lepidoptera

ee Generally without prolegs; never with five pairs of them; usually with terminal spiracles; long, lateral filaments often present on the abdominal segments ..... (beetles) Coleoptera

bb Without jointed thoracic legs; with abdominal prolegs, or entirely legless; in the more degenerate forms, the head is reduced and retracted within the pointed apex of the thorax, no appendages of the imago are visible, and the pupa is formed within the contracted and hardened larval skin (flies, etc.) Diptera

Those orders, on which some life history work was done at our station, are severally discussed below. That some of these, notably the Coleoptera and the Diptera, were slighted, is only too apparent, and no one will be so regretful as we are that no more time could be given to the study of these; but the other orders treated seemed to be in more pressing need of study; and we always had more life history material available than could be attended to by two pairs of hands. A few random notes on the representatives of those orders which received from us no study whatever, will be found grouped together under a final heading.

Order PLECOPTERA

Stone flies

The stone flies are all aquatic. They frequent rapid streams, and are most abundant in those places where the water dashes over heaps of broken, half submerged rocks. In summer one may often see in such places the projecting top of a rock decorated with the empty skins which the adult stone flies left behind when they left the water and acquired wings. To find the nymphs one need but lift a stone from the water quickly, turn it over and look at it. The flat, closely clinging nymphs will be seen with their legs at full stretch and their claws gripping the rock, or running from one depression to another, seeking to hide.

The nymphs are little known. In this country they have received hardly any attention, which is surprising, considering that they are so easy to collect and to rear, and that they live in places in general so attractive to us. The good angler who has the blood of a naturalist in him is likely to know the species of stone flies, both nymphs and adults, better than does the average professional entomologist. The systematic study of the order is little advanced beyond the point where Pictet left it 60 years ago[1]: his work is still the best textbook of the group to be had.

1 Historie naturelle des neuropteres: perlides. Paris 1841.

The nymphs of stone flies require well aerated water. They can not live in a stagnant pool[1], or in a foul stream. A large number of the smaller species, including the two described below, are entirely destitute of gills. With these the air supply is absorbed directly through the thin skin of the ventral surface. At the ventral sutures one can readily see that the skin is fully permeated by fine tracheal branches. Stone fly gills at their best development are but small tufts of delicate respiratory filaments attached to the ventral surface of the body, oftenest about the bases of the legs, swished about by the motion of other parts, or dependent on the motion of the water for the renewal of the oxygen supply. Nymphs brought in from the brook and placed in a vessel of still water will soon be seen with claws affixed vigorously swinging the body up and down, trying to get a breath under the difficult conditions into which they have been brought.

In two important respects the nymphs of May flies and dragon flies have surpassed those of stone flies in the development of aquatic respiratory apparatus:

1 In developing flat, plate like gills, which offer greater surface for contact with the water;

2 In developing special apparatus for the independent movement of the gills, or for causing currents of water to flow over them.

It is the smaller species that are gill-less. The extent of respiratory surface is in a measure proportioned, 1) to the size of the nymphs; 2) to the condition of the water, whether well or poorly aërated.

It is because of the limitations on the respiratory system of stone-fly nymphs that they are so restricted in their aquatic habitat.

As to the food of the stone flies there have been a number of guesses, but apparently no careful and continuous observations recorded. It is supposed that the nymphs of the larger species eat smaller May fly nymphs, and soft-bodied dipterous larvae associated with them on the rocks; but Benjamin D. Walsh has said that perlid nymphs eat decaying vegetable matter, and that the imagos eat nothing.[2] Here, then, is an opportunity for some careful observer to replace inferences with facts.

The adult stone flies may be collected at almost any season of the year. The little black capnias emerge in winter. They live mainly in small brooks, and are often found in transformation on the edge of the ice. Through the spring months the dusky and grayish little nemouras

1 I have bred a species of Acroneuria in some numbers from nymphs taken from rotting oak leaves in the edge of an ice pond at Ithaca N. Y.; but the water about the bed of leaves was clear, and could not be called stagnant, since the turbulent Cascadilla creek flows through the pond.

2 Practical entomologist. 2:73.

are emerging; but the larger stone flies, and the paler and green ones are to be looked for mainly in summer.

Stone flies are abundant in most parts of the state of New York. Every rocky stream swarms with them. But about Saranac Inn there are no rocky streams. The creeks flow leisurely over beds of sand or filter through mats of river weed, and are destitute of the stony obstructions which afford suitable shelter for young stone flies. But two of the smaller species were studied there, and these were neither abundant nor very important members of the aquatic fauna. Both live in Little Clear creek and in the pipes which bring water to the hatchery, and both were taken as adults at the hatchery windows. Nathan Banks has published keys to the North American genera of stone flies in the *Transactions of the American entomological society*, 20:328–29; and 26:240–42. The student is referred to these.

CHLOROPERLA

This genus includes a small number of delicate, pale green stone flies about half an inch long. At emergence they fly to the shelter of green vegetation, and thereafter remain concealed most of the time, returning to the water, perhaps, to deposit their eggs. So far as known, the nymphs which live in clear streams are entirely destitute of gills. C. A. Briggs has recorded a curious habit of the adult male of Chloroperla.[1] Placed in a box, it struck the bottom with its penultimate abdominal segment to make a noise.

Chloroperla bilineata Say

1823 Sialis bilineata Say, Godman's western quarterly reporter. 2:165 (original description)
1839 Chloroperla transmarina Newman Ann. & mag. nat. hist. (2) 3:87
1841 Chloroperla transmarina Pictet, Perlides, p. 283
1852 Chloroperla transmarina Walker, Cat. neur. ins. Brit. mus. 1:161
1852 Chloroperla picta Walker, Cat. neur. ins. Brit. mus. 1:161
1861 Chloroperla bilineata Hagen, Synopsis Neur. N. Am. p. 30
1892 Chloroperla bilineata Banks, Am. ent. soc. Trans. 19:342 (listed)
1899 Chloroperla bilineata Banks, Am. ent. soc. Trans. 25:200 (included in a key to species of Chloroperla)

This species was taken only in the hatchery. It was already disappearing when we arrived, June 15. A few could be found about the windows each day. Many more dead ones were discovered in the hatchery loft, entangled in spiders webs, or fallen on the window sills,

1 Ent. month. mag. 1897. 33:207–8.

having made their way upstairs, seeking their freedom. They were not observed flying, except from the place of transformation to the window.

Empty nymph skins were, on the contrary, very abundant. There were hundreds sticking to the sides of the hatchery troughs, thickest near the inflow pipe, but some were to be found on all the troughs.

Observing that the season for the species was waning, we lost no time emptying the supply trough and sifting its contents. Thus we obtained two nymphs, one of which was reared.

Imago. Length to tip of wings 12 mm; antennae 7 mm more. Setae two thirds as long as the abdomen, hardly surpassing the tips of the wings. Expanse of wings 21 mm.

Color light green. Antennae brownish black, except a small paler part just beyond the base. A broad U-shaped mark on the top of the head, just including the ocelli. A blackish brown stripe each side of the prothorax, darkest anteriorly, continued on the mesothorax, diffused posteriorly. Abdomen greenish, washed with brown dorsally, specially toward its lateral margins. Setae brownish. Legs greenish, a little darker exteriorly and at the tips of the tarsal segments. Wings green; veins very faintly touched with brown.

Nymph. Fully grown, measures 9 mm; setae 3.3 mm more.

Body slender, slightly depressed. Head hardly wider than prothorax or than abdomen; the latter a little widened in the middle and a little more narrowed at the posterior than at the anterior end.

Color greenish to pale brownish. Antennae green at base, becoming brownish at tip, stout at base, rapidly tapering. The broad U-shaped mark on the top of the head in the adult is present in the nymph, the base of the U being laterally extended in a transverse band which meets the eyes and extends two angles anteriorly toward the mouth each side. Prothorax with two lateral stripes, darkest anteriorly. Two pairs of small spots on mesonotum and on metanotum between the bases of the wings.

Abdomen with three distinct blackish brown stripes, a median one and two lateral ones, the latter ending on the bases of the setae. Setae stout at base, rapidly tapering; brown at base, becoming paler distally. Legs pale greenish. Ventral aspect, whitish or pale green.

No tracheal gills.

Numerous specimens. Adirondack hatchery, Saranac Inn N. Y. June. Observed till June 21, when the last specimen was taken.

LEUCTRA

This genus includes the slenderest of stone flies; small, brownish species, with wings closely inwrapping the body on the dorsal side. Mr McLachlan says that the females in this genus carry their eggs on their backs, extruding them from the upturned end segment of the abdomen and pushing them toward the bases of the hind wings.[1]

1 Ent. month. mag. 1865. 1:216.

Leuctra tenella Provancher (pl. 15 and fig. 4 and 5)

1878 Leuctra tenella Provancher, Petite faune entomologique du Canada. p. 80[2] (without description)

1892 Leuctra tenella, N. Banks, Am. ent. soc. Trans. 19:343 (cited)

This species was much less common than the preceding one. Adults were not observed in flight. A few were taken in the following places: at the hatchery windows; on aquatic vegetation close above the surface of the water; and under the ends of some boards which overhung the water at the railway embankment, where the water pours out of the culvert, forming a little riffle. In this last mentioned place the nymphs were obtained. They were found crawling over the surfaces of the stones and boards among the brown and empty cases of Simulium pupae. One was bred July 31. Sweepings by day alongside the creek and trap lanterns by night failed to find this species.

From the foregoing bibliographic notes it will be apparent that this species is still practically undescribed.

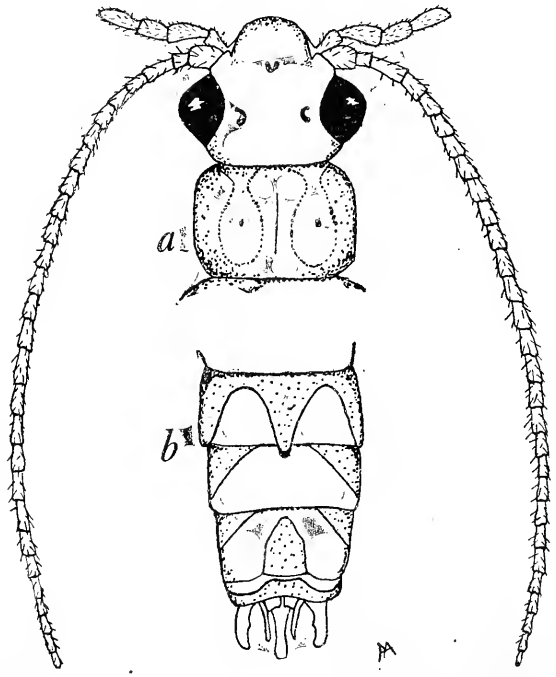


Fig. 4 Leuctra tenella, male: *a*, dorsal view of head and prothorax; *b*, end of male abdomen

Imago. Length, male 7.5 mm, female 9 mm to tip of wings; antennae, 5 mm. First and fourth segments of antennae of about equal length, the third longer, the second shorter, about 34 segments in all;

moniliform; not close set cylindric and tapering as in the more typical Perlidae. Median ocellus clearly double!

Body slender, with sides nearly parallel. The prothorax narrower than the head, regularly quadrangular, with straight sides and ends, and with angles all a little rounded; a faint median raised line and on either side of it a faint raised circle covering nearly half of the prothoracic dorsum.

Color brown, becoming yellowish on legs and sutures. Wings smoky hyaline with brown veins (*see* pl. 15, fig. 12).

On the dorsum of the abdomen in the male there is a conspicuous prominence on the seventh segment which rises to a hight equal to one fifth of the thickness of the abdomen (fig. 4*b*).

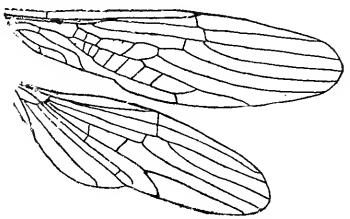


Fig. 5 Wings of Leuctra tenella

Nymph. Fully grown, measures 12 mm in length of head and body; abdomen alone 4.5 mm; antenna 4.5 mm; abdominal setae 4.5 mm. Width of head .9 mm.

Body with nearly parallel sides. Head as wide as the prothorax; mesothorax a little wider; abdomen a little narrower.

Color nearly uniform yellowish fulvous, pale below and on sutures, antennae and setae. Legs pale yellow. Eyes blackish; ocelli brownish, with a faint wash of brown between the posterior pair.

No tracheal gills.

Little Clear creek at Saranac Inn N. Y. June 21, 24, 26, 28, July 31 and Aug. 2, 1900. Not common.

The two stone flies discussed above fall in separate divisions of the family, which I regard as subfamilies, distinguishable by the following characteristics.

1 **Perlinae.** *Imago.* The median vein hardly fused with the radius at the base, but running close beside it, and bending away from it very gradually, not forming a distinct arculus.

Nymph. Flat body, flattened femora ciliate on the sharp and convex margins, and with tapering abdomen. Tracheal gills, when developed, consisting of tufts of filaments.

This subfamily includes the two tribes, Pteronarcini and Perlini of Banks.[1]

2 **Nemourinae.** *Imago.* The median vein fused with the radius at the base, then bending sharply away from it to meet the cross vein, with which it forms a distinct arculus.

Nymph. More cylindric body; femora not flattened or sharp edged; abdomen with nearly parallel sides. Tracheal gills when developed

1 Am. ent. soc. Trans. 1900. 24:240.

consisting of single, isolated filaments.[1] This subfamily includes the two tribes, Capnini and Nemourini of Banks.

Order EPHEMERIDA

May flies

Family EPHEMERIDAE

The May flies are all aquatic. A few of the larger species, which suddenly appear in countless numbers on the shores of our larger bodies of water and as suddenly disappear again, are very well known. But most May flies, being less concerted in their period of adult life, emerging a few at a time, resting under cover and returning to the water in the twilight to oviposit, are little observed.

The nymphs live in all sorts of fresh water, and are almost everywhere abundant. They are differentiated into highly specialized groups, each finely adapted to its own peculiar situation. There is great apparent similarity among the imagos; but the nymphs of the several principal groups are strikingly unlike. The struggle for existence has fallen mainly on the nymphs, and they have specialized for themselves, more or less independently of adult life. On this account, the beginner will find the study of the group greatly facilitated by collecting the nymphs along with the adults.

Nathan Banks has twice published keys for the determination of the genera of our North American May fly imagos, in the *Transactions of the American entomological society*, 19:332 and 26:246–47. Nearly all our species are described in Eaton's monograph.[2] The following table will serve for the separation of the nymphs of the genera occurring in our fauna. It will also serve to indicate what I believe to be the three principal natural divisions of the family, corroborated by important characters pertaining to both adult and nymphal life. It is based in part on the figures and tables of Pictet[3], Vaysseire[4], Eaton[2], and Schiller[5], but mainly on my own breedings of New York May flies. So few species have as yet been reared that this table will doubtless need considerable revision when more of the nymphs are known.

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1 Rarely developed. They are known from the European Nemoura cinerea Oliv., in which species there are six separate filaments at the front end of the prothorax beneath. An undetermined species of Nemoura, bred by me at Ithaca N. Y. possessed no gills whatever. I also bred at Ithaca an undetermined species of Taeniopteryx the nymph of which had attached to the posterior side of each coxa a single, tapering, three jointed, telescopic, gill filament.

In the Perlinae, the number of filaments in a tuft often increases with the age and size of the nymph.

2 Eaton. Revisional monograph of recent Ephemerinae. Linn. soc. Lond. Trans. (2) 3, 1883.

3 Pictet. Histoire naturelle des neuropteres: Ephemer. Paris 1843.

4 Vaysseire. Organization des larves des Ephemerines. Sci. nat. zool. Ann. (6) 11, 1881.

5 Schiller. Die Ephemeriden-larven Sachsens. Sitz. u. abh. der. naturwiss. ges. Isis in Dresden. 1890. p. 44–49, 2 pl.

GENERA OF EPHEMERID NYMPHS IN EASTERN UNITED STATES

a Body flat, widest across the rear of the head; eyes dorsal; legs depressed; adapted for clinging closely to flat surfaces. (Imagos have five freely movable segments to the hind tarsi)
(HEPTAGENINAE) Heptagenia, *sens. lat.*

aa Head not so wide as succeeding parts of the body; eyes lateral; (imago with but three or four freely movable segments to the hind tarsi, the basal segment at least coherent with the tibia)

b Body widest across the mesothorax; legs of the first and second pairs about equidistant at the base. (Imagos have the cubitus and the first anal vein nearly parallel toward the base) (BAETINAE)

c Gills completely concealed under the enormously enlarged, conspicuously four spined mesonotum ..... Baetisca

cc Gills exposed; mesonotum normal

d Outer caudal setae fringed only on the inner sides; gills on abdominal segments 1–7; agile swimmers

e Gills simple

f Gills oval in outline, obtuse at the apex..... Baetis

ff Gills lanceolate in outline, acute at the apex.. Centroptilum

ee Gills double, at least the anterior pairs

f Antennae hardly longer than the head; the thin lateral margin of the eighth abdominal segment produced posteriorly in a very large flat tooth; ocelli on the face..... Siphlurus

ff Antennae longer than half the body; the posterolateral angles of the eighth abdominal segment not forming a conspicuous tooth; ocelli generally on the top of the head

g Antennae shorter than the body; gill tracheae pinnately branched Callibaetis

gg Antennae longer than the body; gill tracheae palmately branched Cloeon

dd Outer setae fringed on both sides

e Gills on abdominal segments 1–7, double, similar

f Divisions of the gills narrowly linear..... Leptophlebia

ff Divisions of the gills leaflike, each with a terminal filament Blasturus

ee Gills absent from one or more of abdominal segments 1–7, one pair more or less elytroid, covering those behind it

f Gills present on the seventh abdominal segment, elytroid on the third or fourth segment; a pair of minute tubercles at the apical margin of each abdominal segment beside the median line Ephemerella

ff Gills absent from the seventh abdominal segment, elytroid on the second segment; no dorsal abdominal tubercles..... Caenis

bb Body somewhat compressed, widest across the base of the abdomen; legs of the first pair much more closely approximated at the base than those of the second pair; all the legs appressed against the sides of the body and adapted for burrowing; mandibles usually produced anteriorly in a long, curved tusk. (Imagos have the cubitus and the first anal vein strongly divergent toward the base) EPHEMERINAE

c Head without frontal prominence; gill rudiment on the first abdominal segment simple..... Polymitarcys

cc Head with a frontal prominence; gill rudiment on the first abdominal segment bifurcated, shaped like a tuning fork

d Frontal prominence rounded; the flattened fore tibia with a broad, rounded lobe at its apex, close behind the apical burrowing hook Hexagenia

dd Frontal prominence bispinous; no conspicuous lobe at the apex of the fore tibia behind the apical burrowing hook... Ephemera

I describe below the nymphs of seven species of May flies, representing as many genera, bred at Saranac Inn. The only bred North American nymph of which I find description is the singular Baetisca obesa Say, which is figured by Walsh, Vaysseire and Eaton. A number of undetermined American nymphs, mostly from the Cambridge museum of comparative zoology, are figured and described in Eaton's monograph. One of these I have been able to identify as Ephemerella excrucians, described below.

Heptagenia pulchella Walsh

Plate 15, figure 15

1862 Palingenia pulchella Walsh, Acad. nat. sci. Phil. Proc. p. 375 (original description)

1863 Palingenia pulchella Hagen, Ent. soc. Phil. Proc. 2:177 (note)

1863 Palingenia pulchella Walsh, Ent. soc. Phil. Proc. 2:203 (note)

1863 Heptagenia pulchella Walsh, Ent. soc. Phil. Proc. 2:204 (merely refers it to Heptagenia)

1871 Heptagenia pulchella Eaton, Ent. soc. Lond. Trans. p. 141 (description in Latin from the original by Walsh)

1885 Heptagenia pulchella Eaton, Linn. soc. Lond. Trans. (2) 3:299 (a very full description)

1892 Heptagenia pulchella Banks, Am. ent. soc. Trans. 19:347 (listed)

Imagos of this species were common in the hatchery windows throughout our session, and during the month of June were most abundant there. A few, mostly males, were taken regularly in the trap lanterns when the weather was favorable. A few others were seen, flying in the twilight. The species was little in evidence, common as it was.

The nymphs were abundant in Little Clear creek, specially in the more rapid places, clinging closely to flat surfaces of boards, sticks, stones, etc. To collect them one needed but to lift these obstructions from the stream and pick the nymphs from them with forceps. Within a few days after our arrival we had reared some of the nymphs, and others were reared repeatedly after that. Oviposition was not observed. I dissected a female subimago, and counted the eggs in her ovaries in part, and, on the basis of this count, estimated the whole number at about 1340. Imagos and subimagos thrown on the surface of the fish ponds

were snapped up eagerly by the trout. The membrane of the wings of the imago is in this species finely iridescent.

Nymph. Pl. 15, fig. 16 Length of body 10 mm; setae, male 12, female 15 additional; abdomen, male 6.25, female 7.

Body flat; lateral margins of the head and prothorax thin, sharp edged, flaring, that of the head projecting distinctly beneath the eyes, antennae reaching the tips of the extended fore femora; all femora flattened, sharp edged, edges very convex and fringed with hairs.

Color yellowish or greenish brown, mottled, paler below, and dorsally marked with paler spots as follows: an inverted, mushroom-shaped spot before the middle ocellus, a triangular patch between each reniform, lateral ocellus and the eye, a transverse band at the rear of the head; an oblique band each side of the prothorax, a large lateral spot each side of each of the intermediate abdominal segments with a black mark at its hind margin. The femora and tibiae show very indistinct transverse banding of color.

Abdomen with sharply toothed posterolateral angles on its hindmost segments, the tooth largest on the eighth segment, where it surpasses the middle of the ninth segment, smaller on the seventh and ninth, and a mere sharp angle on the sixth segment. Setae sparsely fringed with hairs for a third of their length.

Gills present on segments 1–7, similar on 1–6, though becoming smaller posteriorly. Anterior gills double, the anterior leaf thickened, trapezoidal with the angles all obtuse, a sparse fringe of slender hairs around the distal half of its border, a strong oblique, longitudinal ridge on its anterior face near its ventral edge; posterior leaf thin and delicate, covered by the anterior, smaller than the anterior, cordate triangular in general outline, cut into a peripheral fringe of long respiratory filaments which are once or twice forked or simple, the fringe being as long as the body of the leaf. Gill of the seventh segment simple (corresponding to the anterior leaf only), lanceolate, fringed along its entire margin, its apex surpassing the lateral tooth of the eighth abdominal segment.

This species is known from Rock Island Ill., Maryland, New York and Quebec.

There is in the Museum of comparative zoology a specimen of another species labeled "Adirondacks, New York, Aug. 1872" in Dr Hagen's handwriting, which agrees entirely with other specimens in the same museum bearing the name Heptagenia vicaria Walker.

Baetis pygmea Hagen

Plate 15, figures 13, 14

1861 Cloe pygmea Hagen, Synopsis Neur. N. Am. p. 54 (original description)

1863 Cloe pygmaea Hagen, Ent. soc. Phil. Proc. 2:178–79 (notes, "It is the smallest ephemerous species known.")

1871 Baetis pygmaeus Eaton, Ent. soc. Lond. Trans. p. 122 (original description, repeated in Latin)

1885 Baetis pygmaeus Eaton, Linn. soc. Lond. Trans. (2) 3:170 (a new description of the fragments remaining of the type)
1892 Baetis pygmaea Banks, Am. ent. soc. Trans. 19:348 (listed)

All the above are bare descriptions of the single female specimen in the Hagen collection from the St Lawrence river.

I studied this fragmentary type specimen in Cambridge Aug. 25 and 28. There remains of it a bit of the thorax, bearing the greater part of one fore wing. The venation of this wing furnished the only points for critical comparison with my specimens. The descriptions and the type specimens agree fairly well with the smallest of my specimens. I could not see the brownish color of the veins described by Eaton either in my specimens or in the type. Also the veins in the pterostigmatic space vary in number in my specimens from 5 to 12, and from being simple and straight to being forked and anastomosing.

This species, like the preceding, was common in the hatchery windows, was taken often sparingly in the trap lanterns, and was seldom seen at large. Imagos occurred more sparingly, however, through the earlier part of the season, but they became very abundant in August. From the window in the hatchery nearest the mouth of the inflow pipe carrying surface water, hundreds of imagos and subimagos could be picked at a time. These were preyed on in great numbers by spiders which lurked in the crevices of the window casings. Not a few flew against the window panes when these were wet with condensations in the mornings, and, striking their wings, adhered, and were unable to free themselves. When the moisture evaporated, these were dried down on the glass. Among these I noticed a number of females which had discharged the contents of their ovaries on the pane in masses of about 200 eggs each.

Nymphs of this species were found most abundantly among the cases of Simulium pupae in swiftly flowing water; a few could be taken at any time from the hatchery troughs.

This is the daintiest, and one of the prettiest of our May flies. It is still so insufficiently known that I will append hereto complete descriptions of the stages known to me.

Male imago. Length 3–5 mm; setae 7 mm additional. Colors black and white varied with reddish brown and yellowish red. Head yellowish, with the ocelli and the inferior part of the eyes black, turbinate superior part of the eyes yellowish red on the sides, reddish brown on the superior, corneal surface.

Thorax black, paler on the lateral sutures. Legs, antennae and setae pale yellowish white; fore legs darker on the sutures. Wing very transparent with a faint wash of yellow on the extreme base. Hind wing bivenulate, sometimes with a short third vein.

Abdomen black and white; segments 2–5 pure white (in old males) with black spiracles; segment 6 yellowish; segments 7–10 black, paler below.

Male subimago (undescribed). Differs only in having the setae about 5 mm long (as in the female); and in lacking strongly contrasting black and white colors on the abdomen, all the colors being duller, the wings merely translucent, with a fine fringe of hairs.

Female imago. Length 3–5 mm, setae 5 mm. Color reddish brown, darker on the thorax and paler beneath the body; discoloring badly when pinned. Head and thorax brownish with ocelli paler and eyes black. Thoracic dorsum brown, darker on the ridges, with a pair of oblique pale stripes extending from the hind angles of the prothorax to the wings, and a pair of narrow, submedian, longitudinal stripes on the mesothorax.

Abdomen reddish brown, apical segments paler.

Female subimago. Differs in obscurer coloration; on the top of the mesothorax there is a single wide middorsal longitudinal stripe.

Known only from the St Lawrence river and Saranac Inn. Specimens are deposited at Cambridge in the Museum of comparative zoology and in the New York state museum.

Nymph. Measures 4–5 mm; setae 2.3–2.5 mm additional; antennae 2.2 mm.

Body slender, graceful, smooth, clean; brownish above, yellowish beneath and on the sutures; a narrow middorsal yellowish line, dilated on the middle of the mesothorax, and expanded again into a quadrate spot at the front of the prothorax; paired yellowish markings beside this line, and numerous small yellowish spots nearer the sides; legs and antennae yellowish. Setae with a brownish shade near the bare tip; all fringes short; the two outer setae fringed only on the inner side.

Gills present on abdominal segments 1–7. small, separate, widely extended and fully exposed; each leaf obovate, a little oblique, with a chitinous thickened inferior border, this border, short on the foremost gill leaf, reaches the apex on the sixth one, and comprises the greater part of the narrow, reduced seventh one.

The face is vertical, with the ocelli in front, somewhat as in Siphlurus.

The nymph is an exceedingly agile, little fellow, darting hither and thither with astonishing speed when one tries to pick it up.

A few specimens of a larger, undetermined species of Baetis were taken at the hatchery windows.

Siphlurus alternatus Say

Plate 11, figure 7

1824 Baetis alternatus Say, Godman's western quart. reporter, 2:304
1859 Baetis alternatus Leconte (ed.), Complete writings T. Say, 1:204
1861 Baetis alternatus Hagen, Synopsis Neur. N. Am. p. 49
1862 Baetis alternatus Walsh, Acad. nat. sci. Phil. Proc. p. 369
1863 Baetis alternatus Hagen, Ent. soc. Phil. Proc. 2:169

1863 Baetis alternatus Walsh, Ent. soc. Phil. Proc. 2:189
1853 Baetis annulata Walker, List Neur. ins. Brit. mus. 3:567
1861 Baetis annulata Hagen, Synopsis Neur. N. Am. p. 48
1876 Baetis femorata Provancher, Nat. Canadienne. 8:267
1877 Baetis femorata Provancher, Faun. ent. du Canada. 2:83
1871 Siphlurus annulatus Eaton, Ent. soc. Lond. Trans. p. 127 (description in Latin: figures of forceps of male, and ventral abdominal markings in pl. 6, fig. 4 and 4a)
1871 Siphlurus alternatus Eaton, Ent. soc. Lond. Trans. p. 129
1877 Siphlurus alternatus Provancher, Faun. ent. du Canada. 2:83
1885 Siphlurus alternatus Eaton, Linn. soc. Lond. Trans. (2) 3:219
1892 Siphlurus alternatus Banks, Am. ent. soc. Trans. 19:346 (listed)

This handsome brown species was not observed at large, was not taken in our trap lanterns, and was only obtained by rearing nymphs. These were not uncommon in shallow water about the outlet of Little Clear pond among the debris of fallen brushwood. Doubtless the imagos might have been found at large, had careful search been made of the shores about these same places.

The nymph is a graceful creature, and exceedingly agile. The beautiful fringes on the abdominal setae constitute a powerful tail fin, one stroke of which sends the nymph through the water with a speed the eye can hardly follow. It is exceedingly difficult to pick up one of the nymphs, when confined in a little dish of water, with a forceps, so quickly will they dart away. In a water net of some size they are easily taken, however, apparently not finding themselves ensnared till lifted from the water. A good many specimens were taken in shallow water behind a large hummock overgrown with cattails (Typha) to the north of the outlet of Little Clear pond. These transformed July 21, 22 and 23, and remained in the subimago stage for more than 48 hours in every case, undergoing the final molt during the second day after emergence from the larval skin.

This species is widely distributed throughout the eastern United States.

Nymph. Pl. 11, fig. 5, 6 Length of body 15 mm; setae 6.5 mm additional; abdomen 9.5 mm; antennae 1 mm.

Body arched, tapering, very graceful and exceedingly well adapted for swimming. Abdomen somewhat depressed and upcurved at the tip. Face vertically elongated, with an aspect singularly like that of the face of the common grasshopper.

Head and prothorax short, each about twice as wide as long; mesothorax large and prominent; abdomen a little wider in the middle, tapering slightly to the end, serrated on each side by the prolongation of the posterolateral angles of segments 1–9 in sharp, single, backwardly directed teeth, which become largest on the sides of the 8th segment, and sharpest and thinnest on the sides of the ninth; 10th segment cylindric, two thirds as wide as the ninth.

Color yellowish or greenish brown, mottled with blackish brown on the dorsal side in a pattern of short streaks. Legs yellowish: femora with a band of brown just beyond the middle; other brownish marks beside or on all the leg sutures; tibia shorter than the tarsus without its claw.

Setae yellow, with a whitish fringe of hairs of silky aspect; a transverse band of brown across them just beyond the middle, and a brownish shade near the tip.

Gills present and double on segments 1–7; the posterior leaf with a chitinous ridge on its ventral (external) margin, not reaching the apex, relatively shortest on the first gill; the posterior leaf trilobed on segment 1, bilobed on segments 2–6, and simple on segment 7; the smaller, thinner and more delicate anterior leaf bilobed on segments 1 and 2, simple on segments 3–7, becoming very small on the seventh segment.

In contrast with the gills of Heptagenia, in which the anterior leaf of the gill is thickened and protects the delicate posterior one, we have in Siphlurus the anterior leaf thin and delicate, the posterior one thickened. The latter, having muscles attached to it internally, thus becomes a swimming organ, capable of a smart backward stroke. Each acts in concert with its fellows and with the tail fin, producing a racing speed for a succession of short dashes through the water. The respiratory gill leaf, being placed at the front, is out of the way of the stroke.

Two specimens of Callibaetis ferruginea were taken at the hatchery windows during the month of August.

Ephemerella excurcians Walsh

1862 Ephemerella excrucians Walsh, Acad. nat. sci. Phil. Proc. p. 377 (original description)

1863 Ephemerella excrucians Hagen, Ent. soc. Phil. Proc. 2:178 (note)

1885 Ephemerella excrucians Eaton, Linn. soc. Lond. Trans. 3:130 (a full description)

1892 Ephemerella excrucians Banks, Am. ent. soc. Trans. 19:347 (listed)

1871 Ephemerella invaria, in part, Eaton, Ent. soc. Lond. Trans. p. 100

Very few imagos of this interesting species were obtained, notwithstanding the nymphs were common in Little Clear creek and even in the hatchery troughs during the month of July. A single pair was bred July 10, transforming to imagos the following day. Specimens were taken at the trap lantern and from the hatchery windows. The species is known from New York, Illinois and Michigan.

The nymph is no. 5 of Eaton's monograph.[1] This being the type species of the genus Ephemerella, a genus the nymphs of which show considerable differences, it is the more desirable that the immature stages should be made known.

[1]Linn. soc. Lond. Trans. 1885. 3:133–34, pl. 40, fig. 18–20, and pl. 64, fig. 3–7. Unknown genus "allied to Ephemerella."

Nymph. Length 8 mm; setae 4 mm additional; abdomen 4.5 mm; antennae 1.5 mm.

Head twice as wide as long; thorax convex; legs short; tibia about equal in length to the tarsus without its claw; abdomen depressed, widened on the fourth to ninth segments, with thin lateral margins, produced at the hind angles into thin, flat teeth, which appear in outline like the teeth of a circular saw; third segment with a minute tooth, first and second segments with none at all, 10th segment with a low, longitudinal, lateral carina; setae fringed in the middle, nearly naked at both ends.

Color dirty yellowish, darker above, paler beneath.

Gills double, well developed on the fourth to the sixth segments, rudimentary on the first and seventh, and absent from the second and third; the opercular anterior leaf on the fourth segment covers all the gills posterior to it; on the fifth and sixth segments the anterior leaf is similar in form but smaller and much thinner; the delicate posterior leaf on the fourth, fifth and sixth segments is two parted; on the first segment is a simple cylindric rudiment, jointed on a low pedicel; on the seventh segment the rudimentary gill is leaflike, single, six lobed.

July 19 quite a number of nymphs were obtained, both from Little Clear creek beside the hatchery and from the hatchery troughs.

Caenis diminuta Walker

1853 Caenis diminuta Walker, List neur. ins. Brit. mus. 3 : 584
1861 Caenis diminuta Hagen, Synopsis Neur. N. Am. p. 55
1861 Caenis amica Hagen, Synopsis Neur. N. Am. p. 55
1871 Caenis diminuta Eaton, Ent. soc. Lond. Trans. p. 95 (description in Latin)
1885 Caenis diminuta Eaton, Linn. soc. Lond. Trans. (2) 3 : 147 (a full description)
1892 Caenis diminuta Banks, Am. ent. soc. Trans. 19 : 348 (listed)

This dumpy, little, nocturnal species was taken abundantly in a trap lantern hung on the side of the boathouse at the outlet of Little Clear pond. 15 to 50 specimens were taken at a single lantern each evening from the 14th to the 18th of July. This appeared to be the season of greatest abundance for the species. It is quite variable in size and in coloration: the best colored of my specimens agree well with Eaton's detailed description; but the size is often much larger, reaching 5–6 mm in length. This may be due to the taking of published measurements from dried specimens, which are always shriveled considerably. The species is generally distributed over the eastern United States.

The nymphs are common among the trash on the bottom in all quiet waters. Their inconspicuous coloration and trashy covering protect

them well. They cling closely to twigs, bark, etc., and will allow themselves to be lifted from the water without stirring.

Nymph. Length 5.5 mm; setae 3.4 mm additional; abdomen 2.5 mm; antenna 2.3 mm.

Body stout, with thick thorax, and short and rapidly tapering abdomen.

Color pale brownish, darker above, obscured by adherent silt, by diatoms, vorticellae, hydras, and other adherent organisms.

Abdomen with large and sharp, flat teeth, made by the projecting posterolateral angles of the third to the ninth segments, largest on segment 7, smallest on segment 3.

Gills present on segments 1–6; on segment 1 minute rudiments; on segment 2 thick, elytroid, covering the functional gills, squarish, the distal and external angles rounded, the basal-internal angle square; there is on the anterior face a piliferous carina, regularly arcuate, near the external margin, extending from the outer basal to the inner distal angle. The gills on segments 3–6 diminish in size posteriorly; they have the shape of the hind wing of a pierid butterfly, and bear a long dense peripheral fringe of respiratory filaments. These filaments are unilaterally several times branched on the anterior side, and are so closely crowded that they overlap in regular series around the margin of the gill leaf. They are longest at the distal end, where they exceed the length of the gill leaf itself.

Setae slender, thinly fringed along both margins, the middle one apparently a little shorter in the males, a little longer in the females than the other two.

Hexagenia variabilis Eaton

Plate 16

1843–45 Palingenia limbata Pictet, Hist. nat. Neur. v. 2 (Ephem.) p. 146, pl. 12 (the original description: this was Serville's name for another species)

1853 Palingenia limbata Walker, List neur. ins. Brit. mus. 3: 548

1861 Palingenia bilineata Hagen, Synopsis Neur. N. Am. p. 41 (a full description)

1862 Palingenia limbata Walsh, Acad. nat. sci. Phil. Proc. p. 373

1863 Palingenia limbata Hagen, Ent. soc. Phil. Proc. 2: 176

1863 Palingenia limbata Walsh, Ent. soc. Phil. Proc. 2: 197–99 (makes the species the type of his new genus Hexagenia)

1868 Hexagenia limbata Eaton, Ent. mo. mag. 5: 85

1871 Hexagenia limbata Eaton, Ent. soc. Lond. Trans. p. 65, pl. 1, fig. 7, and pl. 4, fig. 3 and 3a (description in Latin)

1885 Hexagenia variabilis Eaton, Linn. soc. Lond. Trans. (2) 3: 55, pl. 7, fig. 11c

1890 Hexagenia variabilis Hagen, Stett. ent. zeit. 51: 11–13 (distinguishes this species from bilineata Say by the form of the forceps of the male)

1892 Hexagenia limbata Banks, Am. ent. soc. Trans. 19: 345 (listed)

1888 Hexagenia sp.? (probably variabilis and bilineata) Forbes, State lab. nat. hist. Bul. 3. 2:484–85 (estimate of the value of Hexagenia larvae as food for fishes, based on the examination of the stomach contents of 1221 fishes, representing 87 species, 63 genera, and 25 families: Hexagenia larvae constitute nearly one tenth of all the food taken). Summary in Insect life. 1888. 1:158–61

This species was much less numerous than the other six whose life histories are discussed here. It was found only along Little Clear creek. An occasional subimago was seen in early morning leaving the water and flying weakly to some neighboring tree trunk to rest. A single specimen was taken on the outside of a trap lantern in the morning twilight. A few were picked from the sides of the hatchery building, where they were conspicuous on account of their size.

The nymphs were easily obtained from the bottom of the creek with a sieve net. They were obtainable throughout the season, this species not having a limited period of emergence, as H. bilineata seems to have. Nymphs taken incidentally while collecting, were reared at various times from June 26 to Aug. 1. They were associated in the creek bed with Ephemera varia, described below, but were very much less numerous. In our breeding cages the subimago emerged one night and transformed to the imago the night following.

Nymph. Pl. 16, fig. 2, 3. Length of body 27 mm; setae 12 mm more; abdomen of male 18, of female 21 mm; antenna 4.5 mm.

Color yellow, with some paler longitudinal markings on the thorax; a series of mushroom-shaped marks on abdominal segments 6–9.

Head compressed; a shelf like prominence above the base of each antenna, straight on its front border, round on its exterior side; the frontal prominence semi-elliptic; mandibular tusks long, stout, upcurved, with a line of hairs on their supero-external margin.

Antennae at base, and the sharp edges of the legs, and the lateral margins of the prothorax, densely clothed with long yellowish hairs. The antennae are bare at the tips and do not surpass the extended fore tarsi.

Legs (pl. 16, fig. 3) short, stout, twisted, flattened, closely applied to the sides of the body, and well adapted for burrowing; femora and tibiae scapulate; the tibia produced at its apex into a terminal burrowing hook and scraper, the edges bearing a stiff line of hairs; the hind foot chelate, the distal angle of the tibia forming with the opposed tarsus a pincer.

Gills on segments 1–7; gill of the first segment small and shaped like a tuning fork; of the six following segments large, of a rich purplish color, two leaved, the leaves similar, lanceolate, and densely fringed with minute linear respiratory filaments, which are as long as the greatest width of the gill leaf. On the flat side of each gill leaf is a yellow, longitudinal median line closely bordered on either side by a line of black. All the gills are directed over the back, where they are gently waved back and forth in intermittent, graceful motion.

One of the largest of our May flies; generally distributed over the United States east of the Rocky mountains.

Ephemera varia Eaton

Plate 11, figures 3, 4

1861 Ephemera decora Hagen, Synopsis Neur. N. Am. p. 38 (decora was Walker's name for another species)
1875 Ephemera decora Hagen, Rep't U. S. geol. sur. terr. for 1873; p. 578
1885 Ephemera varia Eaton, Linn. soc. Lond. Trans. (2) 3: 69–70, pl. 63, fig. 12h
1892 Ephemera decora Banks, Am. ent. soc. Trans. 19: 345 (listed)

This dainty New England species was common about Little Clear creek, associated with the preceding species, with which it agrees quite closely in habits. Imagos, while not sought outside our cages, were often seen sitting lightly on the bushes near the banks of the creek. The nymphs were abundant in the bed of the creek till the first of August.

Nymph. Pl. 11. fig. 1, 2 Length of body 18 mm; setae 8 mm additional; abdomen 11 mm; antennae 4.5 mm.

Color yellowish; abdomen with a pair of submedian, longitudinal, brown streaks, laid on yellow ones, which they divide.

Antennae sparsely hairy, much surpassing the tips of the tarsi. Mandibular tusks, approximate, slender, bare, gently up curved and divergent at the tips; femora and tibiae moderately dilated and bearing on their flattened edges copious fringes of hairs.

Gills as in Hexagenia, but slenderer, and less deeply tinged with purple color.

Order ODONATA

Dragon flies

The dragon flies are all aquatic. They frequent fresh water in all sorts of situations, and are probably the most important predatory aquatic insects. They are strictly carnivorous in all stages. The adults feed on a great variety of insects, and the larger dragon flies habitually eat the smaller ones. The nymphs are very voracious, and in many species cannibalistic, the larger nymphs eating the smaller ones; but they eat chiefly other aquatic insects, worms, crustaceans, fish fry, and tadpoles.

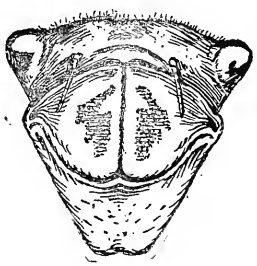

Fig. 6 Face of nymph of Sympetrum illotum Hagen, showing the enormous mask shaped labium

The nymphs may be conveniently grouped according to habits as follows.

a Burrowing nymphs, with depressed, wedged-shaped heads, abbreviated and flattened antennae, approximated fore legs, and external burrowing hooks at the ends of the fore and middle tibiae. These burrow along on the bottom of the pond or stream, just beneath the layer of silt, with the tip of the abdomen turned upward and reaching the water for respiration (Gomphinae)

b Squatting nymphs, with the face vertical and the eyes capping the prominent anterolateral angles. These settle themselves on the trashy pond bottom, some of them covering themselves over completely with sand or silt, and thus await in ambuscade the approach of their prey (Cordulegasterinae, Macromiinae, and some Libellulinae)

c Climbing and clinging nymphs, with cleaner, slenderer, more active bodies, generally showing a definite color pattern, with the head neither cuneate nor vertical in front (Agrionidae Aeschninae, and some Libellulinae)

All nymphs, when ready for adult life, crawl up some support above the edge of the water, fix their claws firmly and transform; the old nymph skin is left attached when the imago flies away. Since this skin preserves well the form of the nymph, and can be pinned for the cabinet, an easy way to gather life history material for dragon flies is to pick them up when newly transformed and before the imagos are ready to fly, place in a coarse paper bag each imago with its cast nymph skin, writing locality, date, etc., on the bag and closing its top, leave a day or more till the imago assumes its mature coloration, and then preserve as specimens, being always careful so to label imago and nymph skin that future mixing of specimens will be impossible.

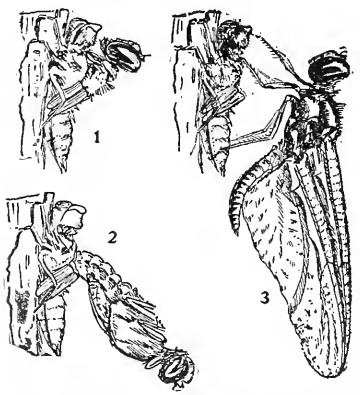

Fig. 7 The transformation of Plathemis lydia Dru. 1, 2, 3, three stages in the emergence of the imago from the old nymph skin

The two suborders, of which but one is treated in this paper, may be readily recognized by the following characters.

a Fore and hind wings similar, held vertically in repose: *nymphs* with three large leaflike respiratory plates at the apex of the slender abdomen, and with the body tapering posteriorly from the head. Suborder ZYGOPTERA: damsel flies

aa Fore and hind wings dissimilar, the latter broader at the base: *nymphs* without external respiratory plates, but with a respiratory chamber included within the wide abdomen; body less slender, and not widest across the head. Suborder ANISOPTERA: dragon flies proper

Suborder ANISOPTERA

The dragon fly fauna of New York state is somewhat more extensive than that of the few other states in which careful collecting has been done. Dr P. P. Calvert has summarized the local lists of the dragon flies of the state in the Journal of the New York entomological society,[1] giving

[1] 1895, 3 : 39-48 and 1897, 5 : 91-96.

all the recorded localities of occurrence within the state. The list includes 102 nominal species. In the suborder Anisoptera belong 67 of these, to which I am able to add 15 species and varieties not hitherto recorded. These are: Ophiogomphus aspersus Morse, O. johannus Ndm. (O. carolus Ndm. has been previously listed as O. mainensis Pack.) Gomphus abbreviatus Hag., Gomphus scudderi Sel., G. quadricolor Walsh, G. furcifer Hag., G. sordidus Hag., G. descriptus borealis n. var., Cordulegaster maculatus Sel., Tetragoneuria spinosa Hag., Cordulia shurtleffi Scudd., Ladona julia Uhl. and Leucorhinia glacialis Hag. I am able also to describe the nymphs of all the genera herein characterized, except two: Gomphaeschna, and Micrathyria, and in many of them, to describe the nymphs of a number of species.

Immature stages in this order are still very little known. Of the 80 species herein discussed, I find that the nymphs of 20 have been more or less completely described and referred to their proper species; 18 of these have been described by Hagen and Cabot, and most of them, well figured; the nymph of one of our species which occurs also in Europe, Libellula quadrimaculata Linn., has long been known in the old world; and recently E. B. Williamson has been able to get for description the nymph of Tachopteryx thoreyi Selys, our sole representative of the Petalurinae and thus to fill one of the most important gaps in our knowledge of the immature stages. Most of these are briefly redescribed below, and 42 new descriptions are added. Thus the early stages are more or less known for 62 of our 80 species.

With three exceptions I have given herein no descriptions of imagos: The descriptive catalogues of Calvert, Kellicott, and Williamson, and other available special papers contain descriptions which it is hardly profitable here to duplicate. In absence of these I trust the keys and tables herein given may be sufficient for the determination of the species.

In the bibliographies given below, completeness has not been aimed at: the student who desires complete bibliography should consult the three following bibliographic catalogues.

Hagen, H. A. Synopsis of the Odonata of America. Bost. soc. nat. hist. Proc. 1875. 18:20–96.

Banks, Nathan. Synopsis, catalogue and bibliography of the neuropteroid insects of temperate North America. Am. ent. soc. Trans. 1892. 19:327–73

Kirby, W. F. Synonymic catalogue of Neuroptera Odonata, or dragon flies. Lond. 1890.

Of these three papers the first named is most complete for the period it covers, and it is the only one containing any reference to the literature of the immature stages.

The four descriptive papers most continuously referred to in the bibliographies of imagos are:

Hagen, H. A. Synopsis of the Neuroptera of North America. Smithsonian inst. Misc. coll. 1861.

Calvert, P. P. Catalogue of the Odonata of Philadelphia and vicinity. Am ent. soc. Trans. 1893. 20:152–272, 2pl.

Kellicott. Odonata of Ohio (a posthumous paper, completed and edited by James S. Hine). O. state acad. sci. Special papers, no. 2. 1889.

Williamson, E. B. Dragon flies of Indiana. Dep't geol. and natural resources of Indiana. 24th an. rep't 1900. p. 233–333, 7 pl.

The first of these papers is out of print; the others may be obtained through the organizations under whose auspices they were published.

The bibliographies given below, being solely designed to aid the user of this paper, are intended to cover the following points.

1 The original description of the species

2 The principal descriptions which have introduced synonyms

3 All available descriptions and figures in American periodicals

4 The records of the occurrence of the species in this state; at least Calvert's summary of such records. (In most cases I have not thought it desirable to go back of this: Calvert's paper is cited on p. 430).

5 All available descriptions and figures of the nymphs of our species.

It will be convenient to treat here as families the two groups that are so recognized in the descriptive works to which our bibliographic references refer. These may be separated by the following keys. The technical terms used in the keys are explained in figures 8 to 10.

KEY TO FAMILIES

Imagos

a Triangle (*see* fig. 9) about equally distant from arculus in fore and hind wing; stigma with a brace vein at it sinner end (except in Cordulegaster) ..... Aeschnidae p. 434

aa Triangle in the hind wing much nearer the arculus than in the fore wing; stigma without brace vein ..... Libellulidae p. 478

Nymphs

a Labium (*see* fig. 8) flat or nearly so, without raptorial setae (except in Cordulegaster, which has the labium spoon shaped, and the median lobe cleft at the summit of a prominent median angle into two divergent teeth) ..... Aeschnidae

aa Labium mask shaped or spoon shaped, when closed covering the face up to the bases of the antennae, armed with raptorial setae.... Libellulidae

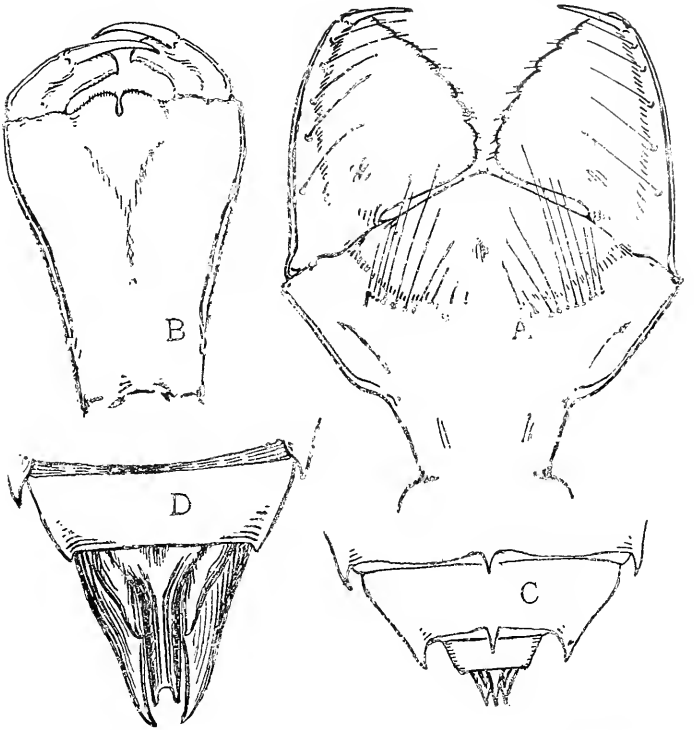

Fig. 8 Group recognition characters for dragon fly nymphs. B and D, labium and end of abdomen of Anax junius Dru. (Aeschninae) A and C, labium and end of abdomen of Perithemis domitia Dru. (Libellulinae)

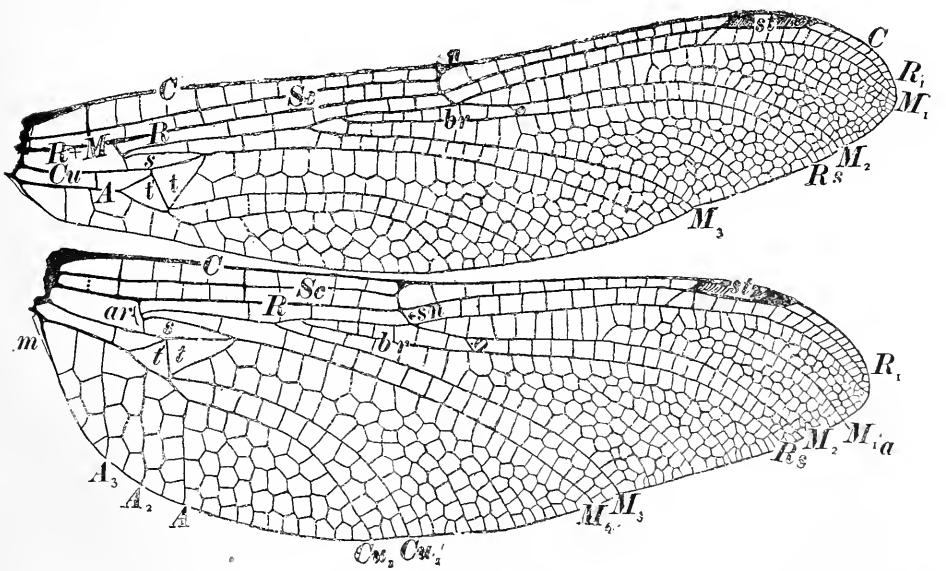

Fig. 9 The wings of Gomphus descriptus Banks. *C* costa; *Sc* subcosta; *R* radius; *Rs* radial sector; *M* media; *Cu* cubitus; *A* anal vein; *n* nodus; *br* bridge; *o* oblique vein; *sn* subnodus; *st* stigma; *ar* arculus; *t* triangle; *t'* subtriangle; *s* supratriangle; *m* membranule. Branches of media, cubitus and anal vein membered at the wing margin. The dotted line in the base of the subcostal space indicates the position of the basal subcostal cross vein when developed.

Family AESCHNIDAE

This family contains four subfamilies that are so different in character and habits they may be best discussed separately. The following keys will serve for their separation.

KEY TO SUBFAMILIES

Imagos

a Stigma braced at its inner end against an inclined cross vein in the space below it (see fig. 9)

b Cubital vein in the fore wing extending directly to the hind angle of the triangle, not appearing forked; subtriangle consisting of one cell, or indistinctly developed

c Eyes widely separated on the top of the head..... Gomphinae

cc Eyes approximated on the top of the head ..... Aeschninae p. 462

bb Cubital vein in the fore wing apparently forked at the base of the second cubito-anal cross vein; subtriangle of three cells. Petalurinae p. 472

aa Stigma without a brace vein..... Cordulegasterinae p. 473

Nymphs

a Labium flat (or with the edges of the lateral lobes slightly upturned in Tachopteryx), and without raptorial setae

b Labium with its median lobe entire; antennae four jointed, the fourth joint rudimentary; fore tarsi two jointed: burrowing nymphs. Gomphinae

bb Labium with a short median cleft (fig. 8B); antennae seven jointed, setaceous; tarsi three jointed; climbing nymphs, with eyes at sides of head Aeschninae

bbb Labium with a shallow median cleft (fig. 15); antennae seven jointed, short; squatting nymphs, with face vertical, and eyes on anterolateral angles; depressed, hairy; tarsi three jointed ..... Petalurinae

aa Labium spoon shaped, with raptorial setae, differs from libellulid nymphs in having the prominent median lobe of the labium cleft into two variously formed teeth at apex (fig. 16)..... Cordulegasterinae

Subfamily GOMPHINAE

Mostly large species, with clear wings, bodies striped with black and green or yellow, of strong but not well sustained flight, inhabiting mostly

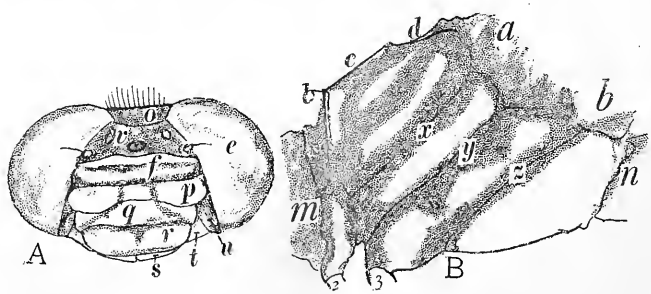

Fig. 10 Diagram illustrating the parts of the head and thorax chiefly used in the tables (Lanthus albistylus Selys.). *A* head seen from front; *e* eye; *f* frons; *p* postclypeus; *q* anteclypeus; *r* labrum; *s* edge of labium; *t* side of mandible; *u* gena; *v* vertex, bearing the three ocelli and the antennae; o occiput. *B* Thorax from the side; *m* prothorax; *n* abdomen; *a* and *b* consolidated meso- and metathorax; *b* collar; *c* carina; *d* crest; *x*, *y*, *z* first (humeral), second and third latural sutures and stripes; 2 and 3, bases of middle and hind legs respectively

flowing or clear water; abundantly represented throughout New York state. The nymphs are burrowers in the beds of streams and ponds. The females oviposit unattended by the males, and liberate their eggs in the water during flight by descending repeatedly and striking the surface of the water with the tip of the abdomen. The eggs have a scanty envelop of gelatin; they tend apart in falling, to lie scattered on the bottom, where they are at once hidden by the silt which adheres to the gelatin. The following key will serve for the separation of the genera likely to be found within our limits.

KEY TO GENERA

Imagos

a Basal subcostal cross vein (*see* fig. 9) present; a linear or spatulate, median, sternal process on the first abdominal segment; legs very short, the hind femora hardly reaching the apex of the first abdominal segment ..... Progomphus

aa No basal subcostal cross vein; no median sternal process on the first abdominal segment; legs longer, the hind femora reaching or surpassing the middle of the second abdominal segment

b Hind wings with a distinct anal loop (*see* fig. 18 a) consisting of several cells

c Anal loop normally consisting of three cells; first and fifth antenodal cross veins matched in position and hypertrophied; stigma broad with both sides convex; triangles not traversed by cross veins. Ophiogomphus

cc Anal loop consisting normally of four cells; first and seventh antenodel cross veins matched in position and hypertrophied; stigma long and narrow with parallel sides; each triangle divided by a cross vein Hagenius p. 440

bb Hind wings with no distinct anal loop, or with one consisting of a single cell

c Triangle of the fore wing one third shorter than that of the hind wing; generally a single cell between the bases of veins A_2 and A_3 .. Lanthus

cc Triangle of the fore wing less than one fourth shorter than that of the hind wing; generally, two or more cells between A_2 and A_3 at their origin

d Hind femora naked, or with numerous short spines Gomphus, *sens. lat.* p. 443

dd Hind femora with five to seven long, strong spines Dromogomphus p. 461

Nymphs

a Middle legs more approximate at the base than are the fore legs; fourth segment of the antenna slender, erect, about as long as the third segment is wide; 10th abdominal segment about as long as the ninth Progomphus

aa Middle legs not more (usually less) approximate than the fore legs at base; the fourth segment of the antenna a mere rudiment, orbicular or discoid, much shorter than the third segment is wide; 10th abdominal segment much shorter than the ninth

b Wing cases strongly divergent on the two sides; lateral lobe of labium blunt at apex ..... Ophiogomphus

bb Wing cases laid closely parallel along the back; lateral lobe of labium ending in a sharp, incurved hook

c Abdomen very thin and flat, circular in outline as seen from above; third segment of antenna flat and subcircular ..... Hagenius

cc Abdomen less depressed, ovate to lanceolate in outline, at least twice as long as wide

d Third joint of antenna very flat, thin, and in outline circular or broadly oval ..... Lanthus

dd Third joint of antenna elongate, linear, little flattened

e Dorsum of the ninth abdominal segment rounded, or with a low, obtuse, median longitudinal ridge ..... Gomphus, *sens. lat.*

ee Ninth abdominal segment with a sharp middorsal ridge, ending in a straight apical spine ..... Dromogomphus

The genus Progomphus has not yet been found in New York state, but it will probably be eventually. It ranges from Massachusetts southward and westward across the continent, a single P. obscurus Selys, having been taken in the whole northeastern United States.

OPHIOGOMPHUS

Four species of this genus are known from New York state. A fifth, O. mainensis Packard is in our lists, but erroneously, I believe. The specimens on which the record is based are in the Lintner collection and in the museum of comparative zoology. I have examined them all, and they certainly belong to O. carolus Ndm., which I believe to be a distinct species. The error seems to have come in the associating of males of O. carolus from New York with the female type of O. mainensis. Our four species may be separated as follows.

KEY TO THE NEW YORK SPECIES

Imagos

a Sides of the middle and hind femora yellow; the inferior abdominal appendage of the male narrower than the superiors, not visible from above

b No black line on the third lateral suture (fig. 10) of the thorax; abdominal segments mostly yellowish or brownish, marked with black apically ..... rupinsulensis

bb Third lateral suture of the thorax black, middle abdominal segments black on the dorsal side ..... aspersus

aa Sides of the middle and hind tarsi black; the inferior, abdominal appendage of the male wider than the superiors, its lateral angles visible from above

c Forks of the inferior abdominal appendage of the male apparently again forked, the apex of each bearing two strong, upcurved teeth separated by a deep rounded notch ..... johannus

cc Forks of the inferior abdominal appendage of the male ending bluntly, the obtuse angles bearing low teeth ..... carolus.

For the differential characters of other North American species, see my paper "Ophiogomphus" in the *Canadian entomologist*, 1899, 31 : 233-38, pl. 5.

Ophiogomphus rupinsulensis Walsh

1862 Erpetogomphus rupinsulensis Walsh, Acad. nat. sci. Phil. Proc. p. 388 (original description)

1890 Diastatomma rupinsulense Kirby, Cat. Neur. Odon. p. 61 (bibliography)

1892 Ophiogomphus rupinsulensis Banks, Am. ent. soc. Trans. 19 : 351 (listed)

1893 Ophiogomphus rupinsulensis Calvert, Am. ent. soc. Trans. 20 : 242 (description)

1894 Ophiogomphus rupinsulensis Banks, Can. ent. 26 : 77 (listed from Ithaca)

1895 Ophiogomphus rupinsulensis Calvert, N. Y. ent. soc. Jour. 3 : 44 (listed from Ithaca)

1897 Ophiogomphus rupinsulensis Calvert, N. Y. ent. soc. Jour. 5 : 93 (listed from Schoharie)

1897 Herpetogomphus pictus Needham, Can. ent. 29 : 181-82 (description)

1899 Ophiogomphus rupinsulensis Needham, Can. ent. 31 : 236, pl. 5, fig. 3, 12, 21, 30 and 31

1899 Ophiogomphus rupinsulensis Kellicott, Odon. Ohio, p. 53-54 (full description)

1900 Ophiogomphus rupinsulensis, Williamson, Dragon flies Ind. p. 298 (full description)

This handsome, widely ranging species has been taken at several places in the state. It was not met with at Saranac Inn. The nymph is unknown.

Ophiogomphus aspersus Morse

1895 Ophiogomphus aspersus Morse, Psyche, 7 : 209 (original description)

1899 Ophiogomphus aspersus Needham, Can. ent. 31 : 236, pl. 5, fig. 2, 11, 20 and 29

This species, hitherto known from three somewhat immature specimens in the Museum of comparative zoology, was common at Saranac Inn. Many imagos of both sexes were observed flying over Little Clear creek in the places where the shallow current rippled over sand. The males would fly back and forth a few times and then rest for a time on some prominent twig near shore, generally on the higher bank. They were not difficult to approach or to capture when at rest. Except when oviposit-

ing, the females seemed to remain less of the time in the vicinity of the water. The female makes a succession of sweeps back and forth near the head of some little riffle, striking the water, after short flights, again and again near the same place, leaving her eggs in it.

Imagos, living and mature, are of a rich, deep green color with the usual oblique stripes of blackish brown. Unfortunately, the color fades readily, even where daylight is excluded. The few imagos which I took the time to gather were nearly all netted while resting on a water pipe which crosses a riffle just below the railroad bridge.

The nymphs were very common in the sandy bed of the creek. A great many were raked up and sifted out with a sieve net while collecting for other material. The cast skins were abundant along the banks through the months of June and July, sticking to whatever support offered, within a foot of the edge of the water.

Nymph. (pl. 18, fig. 5) Total length 27.5 mm; abdomen 17.5 mm; hind femur 5 mm; width of head 5 mm, of abdomen 7.5 mm.

Legs, genae, sides of the antennae, and lateral margins of the abdomen, hairy; the general dorsum nearly bare; well developed burrowing hooks at the apices of the fore and middle tibiae.

Abdomen oval in outline as seen from above, abruptly narrowed on the ninth segment; the 10th segment one third shorter than the ninth; the lateral abdominal appendages two thirds as long as the others; very short, subequal lateral spines on the seventh to the ninth segments; dorsal hooks represented on the second to ninth segments by blunt rudiments, which are erect on the front and posteriorly directed on the hind segments, each surmounting a low transverse ridge, which extends across the dorsum and disappears down on the sides on each segment. Anterior two thirds of each segment, including this ridge, prickly granulate; posterior third polished, shining, smooth.

Mentum of labium one third longer than wide, dilated beyond its basal third and upturned so as to be flaring upward at its edges; median lobe distinctly rounded and fringed with flat scales, and bordered besides with a row of low, broad, rectangular teeth; lateral lobe incurved, rounded on the apex and not bearing a terminal hook or sharp angle, its internal margin bordered with a row of 12 to 15 low teeth.

Color greenish or brownish, with paler and darker mottlings; apical pale rings on all femora; a pair of transversely elongate whitish spots on the dorsum of the seventh abdominal segment, repeated on the eighth segment, but there divided into two spots each side; a whitish spot each side of the 10th segment beside the base of the superior appendage; tips of all the abdominal appendages whitish.

The nymph is a rapid burrower, trailing along at slight depth through nearly clean sand under the currents, often leaving a faint line behind showing where the tip of the abdomen, upturned for respiration, has pushed the sand grains aside.

Ophiogomphus carolus Needham

Plate 20, fig. 1–4, 6, 7

1897 Ophiogomphus carolus Needham, Can. ent. 29:183, pl. 7, fig. 1, 2, 3, 4, 6, 7

1899 Ophiogomphus carolus Needham, Can. ent. 31:235–36, pl. 5, fig. 1 and 28

This species, abundant at Ithaca N. Y. and taken at several other places in the state, was not met at Saranac Inn. It is a very secretive species, few imagos being seen, even where nymphs are excessively abundant. Like the preceding species, the nymphs prefer the sandy beds of running streams.

Nymph. Total length 26 mm; abdomen 17 mm; hind femur 4.5 mm; width of head 5 mm, of abdomen 7.5 mm.

Body moderately depressed, widest across the sixth abdominal segment, suddenly narrowed on the ninth segment. All ventrolateral margins closely fringed with soft hairs. Color yellowish, the surface abundantly sprinkled with brownish granulations visible under a lens.

Abdomen with lateral spines on segments 7–9, a little increasing in length posteriorly, but on the ninth segment distinctly shorter than the 10th segment. Dorsal hooks on these same segments developed as small blunt posteriorly directed prominences, which hardly surpass the narrow, bare apical band on their respective segments, longest on segment 9, and decreasing in size anteriorly so as to be barely represented on segments 6, 5, 4.

Labium as in O. aspersus, but with the 12 to 16 teeth on the inner margin of the lateral lobe a little longer and more angulate at tips.

Easily distinguished from the nymph of O. asperus by the unequal development of the dorsal hooks on the abdominal segments.

This species is very common at Ithaca N. Y. Few imagos have been taken at large, and, indeed, they are rarely met with; but the nymphs may be collected by hundreds from Six Mile creek in spring, and they are very easily reared.

Ophiogomphus johannus Needham

Plate 20, fig. 5

1897 Ophiogomphus johannus Needham, Can. ent. 29:182, pl. 7, fig. 5

1899 Ophiogomphus johannus Needham, Can. ent. 31:235, pl. 5, fig. 9, 18 and 27

The type of this species in the Cornell university collection is from Wilmurt N. Y., and was collected by Prof. J. H. Comstock. Since describing this somewhat immature specimen, I have seen specimens collected in Maine by Prof. Harvey, and in western Pennsylvania by Mr Williamson. From these I learn that the terminal abdominal appendages of the male are not well represented in the figures I have published.[1]

1 Can. ent. 1897. 29:182, pl. 7, fig. 9, 18.

The superiors are well enough (and in these the chief distinctions between this species and O. carolinus Hagen lie), but the inferior is incorrect. It is shrunken in the type from which the figure was drawn; it should be shown almost exactly as in O. carolinus, which is correctly represented in fig. 8 and 17 of the same plate. Mature specimens show also a deep green color on the thorax, and often, the humeral and antehumeral stripes of blackish brown entirely separated at their upper ends.

The cast skin, pinned with the type, is not in fit condition for description, and the nymph is therefore practically unknown.

HAGENIUS

There is a single North American species.

Hagenius brevistylus Selys

1854 Hagenius brevistylus Selys, Acad. Belg. (2) Bul. 21: 82
1861 Hagenius brevistylus Hagen, Synopsis Neur. N. Am. p. 114
1890 Hagenius brevistylus Kirby, Cat. Neur. Odon. p. 75 (bibliography)
1890 Hagenius brevistylus Beutenmüller, Dragon flies vs mosquitos. p. 163 (listed from vicinity of New York)
1892 Hagenius brevistylus Banks, Am. ent. soc. Trans. 19; 352 (listed)
1893 Hagenius brevistylus Calvert, Am. ent. soc. Trans. 20; 241 (description)
1894 Hagenius brevistylus Banks, Can. ent. 26: 77 (listed from Ithaca)
1895 Hagenius brevistylus Calvert, N. Y. ent. soc. Jour. 3; 44 (review of lists)
1899 Hagenius brevistylus Kellicott, Odon. Ohio, p. 52–53 (good description)
1900 Hagenius brevistylus Williamson, Dragon flies Ind. p. 282–83 (good description)

Nymph

1872 Hagenius brevistylus Cabot, Immature state Odon. pt 2, p. 9, pl. 3, fig. 4
1885 Hagenius brevistylus Hagen, Am. ent. soc. Trans. 72: 279–80 (very full description)
1897 Hagenius brevistylus Needham, Can. ent. 29: 168 (characters stated in table for gomphine nymphs)

This big species frequents clear streams, and is common throughout New York state. It is very striking as an adult on account of its great size and black color, and its nymph (pl. 18, fig. 7) is a most grotesque creature.

At Saranac Inn the species was common along Little Clear creek. The nymphs were found in the midst of the trash on the bed of the stream, and, during the season of transformation, exuviae dotted the banks rather conspicuously. Few imagos were seen at large. These fly swiftly from one resting place to another about the stream. They are

easy to approach and proved not very difficult to capture with a net, when resting on the bridges crossing the stream.

The eggs are dropped by the female during flight. She descends and strikes the water repeatedly, at points wide apart: 10 to 20 eggs are liberated at each descent. Thus they are well distributed. Each egg (pl. 19, fig. 2) is somewhat spindle formed in outline with rounded ends, at first of whitish color, becoming yellowish after a few hours. The ovaries of a teneral female from a breeding cage contained no eggs that were nearly mature; a considerable time must elapse after transformation before oviposition can take place.

Nymphs of various sizes are always found together. These sizes fall into three or more possible groups of sizes, which may indicate a developmental period of four or more years duration. In other localities I have observed that the nymphs are likely to be found about the deep holes in the creek bed, under lodged driftwood, etc.; but in Little Clear creek they were found everywhere. Even in the shallow fish ponds made by impounding the creek they were so common on the bottom that one or more could be taken anywhere at almost every haul of the sieve net. 11 exuviae were picked from the boarded side of one of the ponds in a distance of 20 yards.

The nymph has been well described by Hagen and figured by Cabot (*ll. cc.*). There is no need of repeating the description here, since it will be at once recognized by plate 18, figure 7, and by the characters given in the table.

LANTHUS

This genus includes the smallest and the daintiest of our Gomphinae, black species, striped with green. Its two species probably both occur within the state of New York, though but one of them, L. parvulus, has been recorded for the state hitherto. They may be easily distinguished as follows.

Abdominal appendages black ..... parvulus
Abdominal appendages yellow or whitish ..... albistylus

Lanthus parvulus Selys

1854 Gomphus parvulus Selys, Acad. Belg. (2) Bul. 21:56
1857 Gomphus parvulus Selys, Monographie des Gomphinae, p. 157
1861 Gomphus parvulus Hagen, Synopis Neur. N. Am. p. 109
1890 Aeshna parvula Kirby, Cat. Neur. Odon. p. 65 (bibliography)
1892 Gomphus parvulus Banks, Am. ent. soc. Trans. 19:352 (listed)
1893 Gomphus parvulus Calvert, Am. ent. soc. Trans. 20:242 (description)

1894 Gomphus parvulus Banks, Can. ent. 24:77 (recorded from Ithaca)

1895 Gomphus parvulus Calvert, N. Y. ent. soc. Jour. 3:44 (recorded from Ithaca)

1897 Gomphus parvulus Needham, Can. ent. 29:165, 166, 167 (made the type of a new genus, Lanthus: nymph, found at Ithaca N. Y. identified with those described by Dr Hagen from Rocky creek Ky. in Trans. Am. ent. soc. 1885, 12:281 and doubtfully referred by him to Uropetala (Tachopteryx) thoreyi: nymph figured, pl. 7, fig. 8–10)

The habits of the imagos of this species are unknown. The few specimens I was able to obtain at Ithaca in 1897 were all bred, and I saw no imagos at large. The nymphs are very interesting little fellows, quite as different in certain habits as they are in structure and appearance from other gomphines. They seem to prefer little, trickling streams fed by springs, and burrow in beds of sand in the deeper parts. They are more agile than other gomphine nymphs, burrow more rapidly, and, when withdrawn from the water, unlike others, they feign death, and lie quite still for a number of minutes. On account of this habit, as well as on account of the mottled coloration of the body, they are much more difficult to detect while collecting than are the others which begin active struggling as soon as the net is lifted above the water.

Nymph. (Pl. 18, fig. 6 and 20, fig. 8–10) Total length 23 mm; abdomen 14 mm; hind femur 5 mm; width of head 5 mm, of abdomen 6 mm.

Body somewhat depressed, a little hairy on the genae and on the tibiae, elsewhere bare; head concave on the hind margin; antennae, with the two basal segments short and angular, the first a little larger, the articulation between the first and second a little oblique, the third segment obliquely oval, flat, one third longer than wide, with a depressed smooth oval area within the scurfy pubescent marginal rim, the fourth segment a minute round rudiment, at the inner apical angle of the third; labium mentum a little longer than broad, its front border appearing convex by the rounded fringe of scales, in the midst and at the base of which are four to six brown, minute quadrangular teeth; lateral lobe little arcuate, the distal angle produced and inclined internally, but hardly differentiated from the six teeth on the inner margin, these teeth all largest in the middle, and a line connecting their summits would be convex internally.

Abdomen stocky, widened to the seventh segment, and thereafter narrowed, most narrowed on the ninth segment; no dorsal hooks at all, but a median impressed line ending on the seventh segment; lateral spines well developed on segments 8 and 9, on 9 broadly triangular, and considerably shorter than the 10th segment, against the sides of which they are closely applied; 10th segment one half as long as the eighth, one third as long as the ninth, three fifths as long as the superior and inferior appendages; three fourths as long as the others.

Lanthus albistylus Selys

1878 Gomphus albistylus Selys, Acad. Belg. (2) Bul. 46:460 (original description of ♀ from Maine)
1878 Gomphus naevius Acad. Belg. (2) Bul. 46:462 (original description of ♂ from Pennsylvania)
1890 Aeshna albistyla Kirby, Cat. Neur. Odon. p. 66 (bibliography)
1890 Aeshna naevius Kirby, Cat. Neur. Odon. p. 66 (bibliography)
1892 Gomphus albistylus Am. ent. soc. Trans. 19:351 (listed)
1892 Gomphus albistylus Banks, Am. ent. soc. Trans. 19:352 (listed)
1893 Gomphus albistylus Calvert, Am. ent. soc. Trans. 20:242 (description)
1898 Gomphus albistylus Harvey, Ent. news. 9:63–65 (description, figure and notes)

Still known only from Maine and Pennsylvania, in which states, however, Prof. F. L. Harvey and E. B. Williamson, respectively, have collected a goodly number of specimens of both sexes. There is in the Cornell university collection a specimen lacking half the abdomen, probably of this species, from North Carolina. The nymph is not known (unless the ones described by Hagen should prove to be of this species, instead of L. parvulus, as I have supposed. I have not compared my own nymphs with Hagen's types).

GOMPHUS

The United States is the center of abundance for this great genus, and it is nowhere better represented than in New York state. Our list includes 17 regional species, only two of which have not yet been actually taken in the state. They are species of medium or large size, often very local, and locally very abundant. They are found about water, and in woods and copses adjacent to it. They are often flushed from a bare path or roadway; they are perhaps most commonly seen resting flat on the surface of some log which stretches its length across a stream; they rarely perch atop a slender twig after the manner of the skimmers (libellulines). Our species fly mainly in June, though G. scudderi is a midsummer, and G. spiniceps a late summer species.

The nymphs form a most important part of the bottom fauna in all clear waters. They are active burrowers, taking their prey either on or beneath the surface of the bottom silt. They are very rapacious, and will eat almost any living animals small enough to be held by their powerful grasping labia. The nymphs are highly specialized for their peculiar life. They are more unlike than are the imagos, and in general more

easily referable at a glance to their place in the genus. The imagos exhibit with slight variations one color pattern, one plan of venation, one habitus, and are therefore not easy to distinguish. I give below an artificial key to aid in the recognition of our species, and follow it with a synoptic arrangement of the genus, in which is included a statement of the more important characters of lesser groups within the genus. For all of these I prefer to retain the old generic name Gomphus till more of the nymphs are known.

ARTIFICIAL KEY TO IMAGOS

1 Face entirely yellow 2
Face yellow, transversely banded with black 10
Face suffused with brownish black; large, very elongate species, with a distinct anal loop of a single cell, a pair of narrow oblique yellow stripes on the dark background of the thoracic dorsum 14
2 Hind margin of the occiput with a distinct median tooth ..... villosipes
" without " 3
3 Tibiae yellow externally 4
" black " 7
4 Abdominal segments 7-9 strongly dilated about as wide as the thorax fraternus
Abdominal segments 7-9 little dilated, much narrower than the thorax ... 5
5 Length under 45 mm ..... exilis
Length over 45 mm 6
6 Superior abdominal appendages of the male with a sharp inferior tooth; vulvar lamina of the female composed of two acute triangular lobes, one fourth as long as the ninth segment ..... spicatus
Superior abdominal appendage of the male with a low inferior lobe; vulvar lamina of the female composed of two low rounded lobes, and hardly longer than one 10th of the ninth segment ..... sordidus
7 Length under 40 mm ..... abbreviatus
Length over 40 mm and under 50 mm 8
Length over 50 mm 9
8 Abdominal segments 7-9 greatly dilated, as wide as the thorax ventricosus
Abdominal segments 7-9 little dilated, much narrower than the thorax quadricolor
9 Dorsum of the 10th abdominal segment and the superior appendages black ..... descriptus
Dorsum of the 10th abdominal segment and the superior appendages yellow ..... furcifer
10 Yellow of the thoracic dorsum reduced to two narrow, oblique, isolated, yellow stripes ..... scudderi
Yellow stripes of the thoracic dorsum broader, not isolated, dilated at their anterior ends 11
11 Side (anterior face) of the hind femora yellow ..... amnicola
Sides of the hind femora black 12

12 Two cells between veins A_1 and A_2 at their origin; length less than 45 mm ..... brevis
A single cell between veins A_1 and A_2 at their origin; length more than 45 mm 13
13 Midlateral thoracic stripe complete: length about 46 mm ..... adelphus
Midlateral thoracic stripe interrupted, not extending above the spiracle: length about 54 mm ..... vastus
14 Ninth abdominal segment little longer than the eighth, ground color brown ..... plagiatus
Ninth abdominal segment much longer than the eighth; ground color black ..... spiniceps

SYNOPTIC ARRANGEMENT OF THE GENUS, IMAGOS AND NYMPHS

Subgenus GOMPHUS

Imago. Generally with two cells between veins A_1 and A_2 at their origin, when with but one, that one generally longer (in the axis of the wing) than wide, and never so thickened in its bordering veins as to constitute a distinct anal loop; hind femora similar in the two sexes; posterior genital hamule in the male generally nearly vertical in direction, at least not directed anteriorly; eighth abdominal segment generally squarely cut, rarely a very little longer on the dorsal than on the ventral side.

Nymph. Abdomen wider than the head; lateral spines on abdominal segments 6–9; an impressed middorsal line on abdomen more or less evident, often appearing to divide the segments longitudinally, present even on the bases of segments which may bear dorsal hooks apically; median lobe of labium straight on anterior border, or very slightly convex, and not bearing a median tooth.

A synthetic group, offering evident points of departure for the three subgenera which follow it.

KEY

1) Ninth abdominal segment a little shorter than the eighth; two cells between veins A_1 and A_2 at their origin; male with the fork of the inferior abdominal appendage not extending laterally beyond the superiors; female with a low carina on the vertex, at whose extremities arise black thornlike spines; small species.

a) *Imago* Face yellow: *Nymph* Length when full grown 24 mm; lateral spine on the sixth abdominal segment less than half the length of the one on the seventh segment ..... G. abbreviatus

aa) *Imago* Face transversely lineate with black. *Nymph* Length when full grown 26 mm; lateral spine on the sixth abominal segment more than half as long as the one on the seventh segment ..... G. brevis

2) Ninth abdominal segment as long as the eighth, or often a very little longer; inferior abdominal appendage of the male widely forked, its

apices appearing at the sides of the superiors; female generally without thornlike vertical spines.

a) *Imago* A single cell between veins A_1 and A_2 at their origin; segments 8 and 9 of abdomen of about equal length, 7–9 greatly dilated, in width almost equaling the thorax; vulvar lamina of the female about half as long as the ninth abdominal segment. *Nymph* with a broad, obtusely pointed abdomen; lateral spines on the ninth abdominal segment twice as long as the 10th segment, the latter segment thus appearing incased in the ninth; median impressed line on abdomen distinct, and no dorsal hooks except the merest rudiments on segments 8 and 9.

b) Face of *imago* lineate with black. Length of full grown *nymph* 29mm..... G. adelphus

bb) Face of *imago* entirely yellow. Length of full grown *nymph* 33 mm..... G. fraternus

aa) *Imago* Normally two cells between veins A_1 and A^2 at their origin; ninth abdominal segment a little longer than eighth; segments 7–9 less dilated; vulvar lamina of female one third to one 10th as long as the ninth segment. *Nymph* with lanceolate, pointed abdomen; the lateral spines on the ninth segment generally shorter than the 10th segment and not inclosing it; dorsal hooks represented by rudiments of some of the segments before the eighth; impressed middorsal line visible only toward the bases of the middle segments.

b) *Imago* Length 45 mm; legs all black; *nymph* unknown G. quadricolor

bb) *Imago* Length over 50 mm; fore femora yellow or green below; *nymph* with very low, obtuse, inconspicuous rudiments of dorsal hooks.

c) *Imago* Tibiae black externally; inferior abdominal appendage male with an inferior tooth; vulvar lamina of the female about one third the length of the ninth abdominal segment. *Nymph* with about eight to 10 teeth on the inner margin of the lateral lobe of the labium G. descriptus

cc) *Imago*. Tibiae yellow externally; superior abdominal appendage of the male with an obtuse inferior lobe; vulvar lamina of the female about one 10th as long as the ninth abdominal segment. *Nymph* with about six to eight teeth on the inner margin of the lateral lobe of the labium..... G. sordidus

bbb) *Imago* Length about 48 mm; tibiae yellow externally; yellow on the dorsum of abdominal segments 9 and 10. *Nymph* with pointed rudimentary dorsal hooks on segments 6–9..... G. exilis

Subgenus GOMPHURUS

Imago. A single cell between veins A_1 and A_2 at their origin, having a thickened margin, forming an anal loop; abdominal segments 7–9 greatly dilated, as wide as or wider than the thorax: eighth segment cut squarely on apex; posterior hamule of male perpendicular; hind femora similar in the two sexes.

Nymph. Abdomen a little wider than the head, the ninth segment hardly longer than the eighth; lateral spines on segments 6–9, a well marked middorsal impressed line extending to the eighth segment, and very minute rudiments of dorsal hooks on segments 8 and 9; tibial burrowing hooks large; front border of median lobe of labium straight, lateral lobe with its terminal hook bent inward at almost or quite a right angle; apex of abdomen regularly narrowed beyond the middle.

KEY

a) *Imago* Face entirely yellow; *nymph* unknown..... G. ventricosus

aa) *Imago* Face with narrow black lines on sutures; sides of hind femora yellow; *nymph* unknown.....G. amnicola

aaa) *Imago* Face with broad transverse bands of black; hind femora black; abdominal segments with basal rings of yellow; *nymph* with the lateral spines of the ninth segment less than half as long as the 10th segment G. scudderi

aaaa) *Imago* Face with broad transverse bands of black; hind femora black; yellow of middle abdominal segments restricted to triangular spots on the dorsum; *nymph* with the lateral spines of the ninth segment about as long as the 10th segment..... G. vastus

Subgenus STYLURUS

Imago. A single cell between veins A_1 and A_2 at their origin, that cell strongly bordered; abdominal segments 7–9 not greatly dilated (much narrower than the thorax), but considerably elongated; eighth segment cut squarely at apex; posterior genital hamule of male strongly directed anteriorly; hind femora similar in the two sexes.

Nymph. Abdomen narrower than the head, and greatly elongated; tibial burrowing hooks very small; lateral spines, middorsal suture and dorsal hooks of abdomen as in Gomphurus; ninth abdominal segment longer than the eighth, sometimes twice as long.

KEY

a) *Imago.* Ninth abdominal segment of imago much shorter than the seventh. *Nymph* with the lateral spines of the ninth abdominal segment longer by half than the 10th segment..... G. plagiatus

aa) *Imago* with segments 7 and 9 of abdomen about equal in length. *Nymph* with the lateral spines of the ninth abdominal segment shorter by half than the 10th segment..... G. spiniceps

Subgenus ARIGOMPHUS

Imago. Two cells between the base of veins A_1 and A_2 at their origin; eighth abdominal segment obliquely cut at apex, longer on the dorsal side; hind femora different in the two sexes, in the male hairy, and in

the female armed with numerous stout spines below; posterior hamule of male directed posteriorly.

Nymph. Abdomen wider than the head; flattened, lanceolate pointed, suddenly narrowed on the ninth segment, which is longer than its apical width; no impressed middorsal line, instead, a ridge without distinct dorsal hooks; lateral spines on segments 7–9 or 8–9, none on segment 6; median lobe of labium prominently rounded or dome shaped, and usually bearing, besides the usual brush of flattened hairs, a median tooth.

KEY

a) *Imago* with abdominal appendages black; superiors of male with an inferior tooth; *nymph* with bare median narrow ridge on the abdomen; lateral spines on segments 7–9..... G. spicatus

aa) *Imago* with a tooth in the middle of the occipital border. Abdominal appendages yellowish, no inferior tooth on the male superiors. *Nymph* with an obtuse scurfy or rough pubescent middorsal ridge on the abdomen; lateral spines on segments 7–9..... G. villosipes

aaa) *Imago* with no tooth in middle of hind border of the occiput; abdominal appendages yellow; male superior appendages apparently bifurcated at apex; *nymph* unknown..... G. furcifer

Gomphus abbreviatus Selys

1878 Gomphus abbreviatus Selys, Acad. Belg. (2) Bul. 46:464 (original description)

1890 Aeshna abbreviata Kirby, Cat. Neur. Odon. p. 66 (bibliography)

1892 Gomphus abbreviatus Banks, Am. ent. soc. Trans. 19:351 (bibliography)

1893 Gomphus abbreviatus Calvert, Am. ent. soc. Trans. 20:243 (description)

This species is not recorded from New York state. In June of 1897 I found some nymphs at Ithaca N. Y. in Fall creek opposite the Cornell insectary, and bred a few of them. The imagos I did not observe at large. Nothing has been written as to their habits. The species appears to be distributed through the northeastern states as far south as Pennsylvania. It was not found at Saranac Inn.

Nymph. Measures in length 23–24 mm; abdomen 14 mm; hind femur 5 mm; width of head 5 mm, of abdomen 6.5 mm. It differs from G. brevis nymph only in size and in the relative length of the foremost lateral spines on the abdomen, characters already stated in the table; there is no need, therefore, of a separate description of it, since G. brevis is described in full below, and the description would be but repetition of the characters stated for that species. I will therefore add but a note as to the differences of the situations in which I found the two nymphs: abbreviatus in the rocky basins of a gorge traversed by a foaming creek, destitute of the commoner large aquatic plants; brevis, in the bed of a reed-choked, slow flowing, upland stream.

Gomphus brevis Hagen

1854 —— —— Emmons, Agric. N. Y. v. 5, Insects, pl. 15, fig. 2. (colored figure, no name or description)
1878 Gomphus brevis Hagen, Acad. Belg. (2) Bul. 46:464 (original description)
1890 Aeshna brevis Kirby, Cat. Neur. Odon. p. 66. (listed)
1892 Gomphus brevis Banks, Am. ent. soc. Trans. 19:351 (listed)
1895 Gomphus brevis Calvert, N. Y. ent. soc. Jour. 3:45
1897 Gomphus brevis Calvert, N. Y. ent. soc. Jour. 5:93

This species, originally described from specimens obtained by Dr Lintner at Schoharie N. Y., was common at Saranac Inn. I captured but a single imago, and saw but few, but the nymphs were very plentiful in Little Clear creek. The few imagos seen flitted about the edge of the water in the warm sunshine in a manner very similar to that of other small gomphines; oviposition was not observed.

The season of transformation was apparently about ended on our arrival at Saranac Inn in the middle of June; exuviae which I, having bred abbreviatus before, was able at once to refer to this species were thickly sprinkled over the boards on the sides of the fish ponds made by impounding the creek. I collected many of them during the first two or three days of our stay; thereafter but few additional exuviae appeared, the season being past. The species was not bred, but there can be scarcely a doubt that the nymphs, referred to it here by supposition, belong to it.

The original description of this species is not generally accessible in this country; no other has been published, apparently. Therefore, believing that an accessible English description will be of service to some, I give a brief one below, and follow it with a description of the nymph, hitherto unknown.

Imago. Measures in total length 42–45 mm; abdomen 30–33 mm; hind wing 25–27 mm.

Colors black and green; face with heavy black lines on all its sutures and margins, these lines sometimes overspreading the whole face except the upper part of the frons and the sides of the post-clypeus and the labium; rear of the frons, all of the vertex (excepting the tips of its horns), and the front and lateral margins of the occiput black; the occiput otherwise clear yellow, distinctly wider and more convex in the female.

Middorsal thoracic stripe short, with parallel sides, narrowed to a median line before the collar, divided by a yellow carina; humeral and antehumeral stripes contiguous near their upper ends, leaving an isolated yellow triangular spot above, and an isolated narrow line below between them; midlateral thoracic stripe incomplete above, disappearing above the spiracle; stripe on the third lateral suture complete but narrow; legs all black (♂) or with the front femora green beneath (♀).

Wings hyaline; costa black; stigma brown.

Abdomen black with a middorsal line of yellow triangles pointing posteriorly, elongate and twice constricted on the basal segments, becoming very short and restricted to the base on several segments before the ninth, and entirely absent from the ninth and 10th segments. There is a line of yellow at the extreme apex of some of the terminal segments beyond the spiniferous, apical, transverse carina; the 11th segment, "anal tubercle," of the female yellow except at the sides; appendages black; sides of segments 1–3 mainly yellow; segments 4–7 with small basal lateral yellow spots in the female; the slightly expanded lateral margins of segments 8 and 9 yellow in both sexes.

Described from a ♀ from Saranac Inn taken July 2, 1900, and from a ♂ collected on Mt Tom in Massachusetts; the larger measurements are for the female specimen.

This Saranac Inn female was the first imago seen there, and it will be noted that the date is two weeks after the nymphs had ceased emerging. I think this time represents the period necessary for the maturation of the eggs after transformation. A similar lapse of time between the period of transformation and that of oviposition was observed in the case of a number of other gomphines. I believe these insects live longer as imagos than is commonly supposed. As is well known, they will die within a week after transformation if kept in confinement, but apparently no one has tried feeding them well while keeping them as yet. May they not die of starvation?

Nymph. Pl. 18, fig. 3. Total length 26 mm; abdomen 17 mm; hind femur 5 mm; width of head 5 mm, of abdomen 6.5 mm.

Body depressed, abdomen with sides parallel to the eighth segment, then rather abruptly narrowed to an obtuse point; lateral spines on segments 6–9, the margins which bear them thin, and on the ninth segment finely spinulose serrate; spines of the ninth segment about as long as the 10th segment; very minute rudiments of dorsal hooks on segments 8 and 9; before the eighth segment there is an observable trace of the median impressed longitudinal line of the typical Gomphus nymph. The 10th segment is about one third the length of the ninth.

The mentum of the labium is rather short, little longer than broad; the lateral lobe is very moderately arcuate, its apex forming a short end hook not greatly differentiated from the teeth before it; of these teeth on the inner margin of the lateral lobe there are eight or nine, unequal, the middle ones being slightly largest, angulate, sharp, the line of their apices being convex internally, rather than concave, as in all the following members of the genus.

The color, usually obscured by dirt excepting after molting, is greenish brown, with darker mottlings arranged in transverse bands on abdominal segments, scars on abdomen surrounded with paler color.

The third antennal segment is linear, a little depressed and widened apically, hairy, as is usual, on the margins.

Gomphus fraternus Say

1839 Aeschna fraterna Say, Acad. nat. sci. Phil.Jour. 8:16
1861 Gomphus fraternus Hagen, Synopsis Neur. N. Am. p. 104
1862 Gomphus fraternus Walsh, Acad. nat. sci. Phil. Proc. p. 393
1863 Gomphus fraternus Walsh, Ent. soc. Phil. Proc. 2;238
1890 Aeshna fraterna Kirby, Cat. Neur. Odon. p. 66 (bibliography)
1892 Gomphus fraternus Banks, Am. ent. soc. Trans. 19:352 (listed)
1894 Gomphus fraternus Banks, Can. ent. 26:77 (listed from Ithaca)
1895 Gomphus fraternus Calvert, N. Y. ent. soc. Jour. 3:45 (listed from Ithaca)
1897 Gomphus fraternus Van Duzee, N. Y. ent. soc. Jour. 5:89 (listed from Niagara)
1897 Gomphus fraternus Calvert, N. Y. ent. soc. Jour. 5:93 (listed)
1899 Gomphus fraternus Kellicott, Odon. Ohio, p. 59 (description and figures)
1900 Gomphus fraternus Williamson, Dragon flies Ind. p. 289 (description and figures)
1897 Gomphus fraternus Needham, (nymph) Can. ent. 29, pl. 7, fig. 11 and 12 (figures only; those are reproduced in plate 20 of this bulletin)

This vigorous species seems to prefer the larger bodies of water. The imago is a very strong flyer. It skirts the edge of streams with dashing sweeps which seem to proclaim it master of the situation. I have several times seen it feeding on other dragon flies as large as Mesothemis simplicicollis. The nymph is an active burrower in the bare clay bottoms of streams and lakes under water of considerable depth. I repeat herewith the figures of the nymph (cited above) and add a brief description.

Nymph. Length 31 mm; abdomen 20; hind femur 6.5; width of head 5, of abdomen 9; colors obscured; margins all hairy; tibial burrowing hooks very strong, as long as tibia is wide. Third segment of antenna twice as long as the first and second together, hairy on margins; fourth a minute ovoid rudiment.

Mentum of labrum (pl. 20, fig. 12) squarish before the contracted basal fourth; median lobe very slightly convex, densely fringed; lateral lobe bluntly angular at the apex with 7–11 small teeth on inner margin.

Abdomen (pl. 20, fig. 11) broad, depressed, with sides parallel most of its length, abruptly narrowed beyond the sixth segment, minute dorsal hooks on segments 8 and 9; median groove on anterior segments, well developed lateral spines on segments 6–9 those of 9 about equaling the appendages.

Gomphus adelphus Selys

1857 Gomphus adelphus Selys, Monographie des gomphines, p. 413
1861 Gomphus adelphus Hagen, Synopsis Neur. N. Am. p. 104
1896 Aeshna adelpha Kirby, Cat. Neur. Odon. p. 67 (bibliography)
1892 Gomphus adelphus Banks, Am. ent. soc. Trans. 19:351 (listed)

1895 Gomphus adelphus Calvert, N. Y. ent. soc. Jour. 3:45 (listed from Bethlehem)

1897 Gomphus adelphus Calvert, N. Y. ent. soc. Jour. 5:93 (listed from Kenwood)

The specimens above described and listed were collected in New York state by Drs Fitch and Lintner. The species is also known from Massachusetts. I have not met with it in either immature or adult stage, and know nothing of its habitat or habits.

Dr Hagen has carefully described a nymph from Cambridge Mass., referable by supposition to this species in the Trans. Am. ent. soc. 1885, 12:262. If the nymph be full grown, as he thought, there can be but little doubt that it belongs to this species. However, his description agrees in every point excepting size with G. fraternus bred by me in Illinois. Unfortunately I did not get time while in Cambridge for the comparison of my own nymphs with Hagen's types. I have stated the difference in size in the foregoing table. These being all the differences known to me, I have nothing farther to add concerning this species.

Gomphus quadricolor Walsh

1863 Gomphus quadricolor Walsh, Ent. soc. Phil. Proc. 2:246

1890 Aeshna quadricolor Kirby, Cat. Neur. Odon. p. 66 (bibliography)

1892 Gomphus quadricolor Banks, Am. ent. soc. Trans. 19:352 (listed)

1899 Gomphus quadricolor Kellicott, Odon. Ohio, p. 58 (description and figures)

1900 Gomphus quadricolor Williamson, Dragon flies Ind. p. 288–89 (description and figures)

This species is abroad during the first two weeks of June. It has not hitherto been reported from New York state, but I have seen a specimen collected near Ithaca. The nymph is unknown. I have not seen the imago alive. Prof. Kellicott wrote of it, "It rests on rocks projecting from rapids, or on the banks near by the most rapid parts of streams." (Odon. Ohio, p. 58)

Gomphus descriptus Banks

1896 Gomphus descriptus Banks, N. Y. ent. soc. Jour. 4:195 (from Ithaca)

1897 Gomphus descriptus Calvert, N. Y. ent. soc. Jour. 5:95 (listed)

1900 Gomphus descriptus Williamson, Dragon flies, Ind. p. 293 (description and figures)

1897 Gomphus descriptus Needham, Zool. bul. 1:103–13 (digestive epithelium)

This species is quite abundant at Ithaca, and has not as yet been reported from any other locality. It flies during the latter part of May and the first week of June. I found a meadow beside a patch of woods

a favorite foraging ground for the adults; May 30, 1897, and for several days thereafter, they were flitting about this meadow in numbers, but were so active that it required some time to capture many specimens. I collected once enough nymphs to fill a quart fruit jar from Six Mile

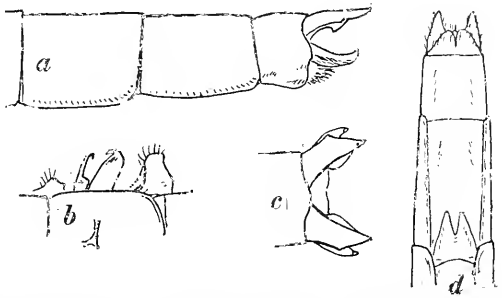

Fig. 11 Genitalia of Gomphus descriptus Banks. *a* lateral view of end of abdomen of male; *b* lateral view of the genital hamules of the male (inverted position); *c* dorsal view of the terminal abdominal appendages of the male; *d* ventral view of the vulvar lamina and end of abdomen of female

creek near Ithaca in an hour. I will mention a variety of this species which occurred at Saranac Inn, before describing the nymph. I bred the species at Ithaca and collected the variety at Saranac Inn, but am unable to find any differences between them in the immature stages; the description will therefore stand for both.

G. descriptus borealis n. var. This is the dragon fly figured by Hagen in Selys's *Monographie des Gomphines* (pl. 9, fig. 2, dorsal view)

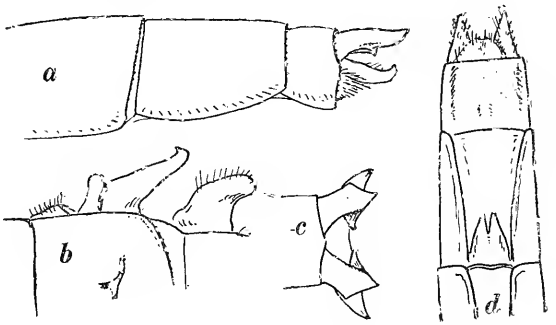

Fig. 12 Gomphus descriptus borealis *n. var.* Lettering as in fig. 11

as Gomphus spicatus. There are several points of difference between this insect and G. spicatus, one of the most obvious of which is the yellow color of the external face of the tibiae in spicatus. The appendages and the proportions of the apical segments of the abdomen are different.

The variety differs from the typical descriptus, so far as observed, only in the form of the appendages of the male abdomen. These differences are shown in the accompanying figures, wherein it will be seen there is a radical difference in the form of the anterior hamule of the male, and that in the variety the superior appendage is shorter, less acute at apex and with the inferior tooth directed more inward than in the typical descriptus.

The variety was first received from Franconia N. H. among some specimens sent me by Mrs Annie Trumbull Slosson. It was not uncommon about Saranac Inn. A few were observed foraging about the Otisville road, and a few others were seen resting on the bare sand of the railroad embankment at the outlet of Little Clear pond. Oviposition was not observed.

Nymph. (Pl. 18, fig. 4) Total length 32 mm; abdomen 20 mm; hind femur 5.6 mm; width of head 5 mm, of abdomen 7 mm.

Body depressed, lanceolate, hairy on all lateral margins, tapering beyond the middle of the rather pointed abdomen. Colors generally entirely obscured by adherent dirt, but after molting there is often seen a darker band across the base of each abdominal segment.

Third segment of the antenna depressed and somewhat widened apically.

Labium with the mentum one third longer than wide; median lobe nearly straight on its front border, fringed with flat hairs, but unarmed; lateral lobe regularly incurved with a long terminal hook, exceeding the six to eight teeth before it on the inner margin.

Lateral spines on abdominal segments 6–9, sometimes obscured by tufts of hairs on the sixth segment, those of the ninth segment short, hardly surpassing the base of the 10th segment, straight, but not closely appressed. 10th segment half as long as the ninth, and a little shorter than the appendages; lateral appendages a sixth to a seventh shorter than the others. Dorsal hooks represented by low, inconspicuous rudiments on segments 3–9, with traces of the median impressed line on the anterior end of the middle segments.

Nymphs of this species were taken at two places: Colby pond, just west of the town of Saranac Lake, and Bone pond. They were associated with and greatly outnumbered by G. spicatus in both places.

Gomphus sordidus Hagen

1854 Gomphus sordidus Hagen, Acad. Belg. (2) Bul. 21:54
1861 Gomphus sordidus Hagen, Synopsis Neur. N. Am. p. 106
1875 Gomphus lividus Hagen, Bost. soc. nat. hist. Proc. 18:45 (listed)
1893 Gomphus minutus Calvert, Am. ent. soc. Trans. 20:244 (♀ only)
1899 Gomphus lividus Kellicott, Odon. Ohio, p. 66 (description and figures)

1897 Gomphus umbratus Needham, Can. ent. 29 : 184 (described, from Ithaca)
1900 Gomphus sordidus Williamson, Dragon flies Ind. p. 292

There are plenty of descriptions and figures of this troublesome species, as will be seen from the above bibliography. I found both imagos and nymphs associated with the same stages of G. descriptus Banks at Ithaca. It is entirely similar to that species in habits, and in appearance, but will be readily distinguished by the characters given in the tables. The nymph is not easy to distinguish, however; in fact, I find it necessary to make a microscopic examination of the labium before being sure as to the species. I bred a good many specimens at Ithaca. By way of description, I will only say that it is entirely similar to the nymph of descriptus, so far as known to me, excepting in the differential character stated in the table.

Gomphus exilis Selys

1854 Gomphus exilis Selys, Acad. Belg. (2) Bul. 21 : 55
1861 Gomphus exilis Hagen, Synopsis Neur. N. Am. p. 108
1872 Gomphus exilis Hagen, Bost. soc. nat. hist. Proc. 15 : 273
1875 Gomphus exilis Hagen, Bost. soc. nat. hist. Proc. 18 : 45
1885 Gomphus exilis Hagen, Am. ent. soc. Trans. 12 : 263–64 (description of the nymph, and remarks on distribution)
1893 Gomphus exilis Hagen, Am. ent. soc. Trans. 20 : 243 (description)
1894 Gomphus exilis Banks, Can. ent. 26 : 77 (listed from Ithaca)
1895 Gomphus exilis Calvert, N. Y. ent. soc. Jour. 3 : 45 (listed from Keeseville)
1899 Gomphus exilis Kellicott, Odon. Ohio, p. 65 (description and figure)
1900 Gomphus exilis Williamson, Dragon flies Ind. p. 293 (description and figure)

This is one of the most generally distributed, and perhaps the commonest of the gomphines of the northeastern United States. At Saranac Inn it was abundant, flitting by every roadside throughout the month of June and well along into July. The nymphs were found in all waters, and about the first of July the exuviae fairly sprinkled every bank. Few imagos were observed in the immediate vicinity of the water, after leaving it at transformation, and these few were mostly females ovipositing. These spin along through the air at a lively rate, unattended by the male, descending here and there to strike the surface and liberate eggs, making but one or two dips in a place, and flying some distance before descending again. The nymphs transform at the very edge of the water, seldom crawling more than an inch or two above the surface of it. Moss-grown logs in the edges of Little Clear pond were in many

places piled several layers deep with the exuviae of this species, intermixed with a lesser number of G. spicatus skins.

Nymph. Total length 26 mm; abdomen 18 mm; hind femur 5.5 mm; width of head 5 mm, of abdomen 6 mm.

Abdomen depressed, lanceolate, regularly narrowed beyond the sixth segment to a rather pointed apex; the 10th segment two thirds as long as the eighth, a little less than half as long as the ninth; lateral spines on segments 6–9, very minute, specially on segment 6, increasing in size posteriorly, on segment 9 one half as long as segment 10: dorsal hooks low and obscure, but pointed on sixth to ninth segments.

Labium with its median lobe a very little convex on the front margin, and sometimes with an imperfect median tooth; lateral lobe considerably arcuate, with a strong end hook, and with 4–7 very variable teeth on its inner margin, each tooth obliquely truncate, with the longer angle directed to the rear.

This species and G. sordidus, offer an easy transition to the Arigomphus group, below.

Gomphus ventricosus Walsh

1863 Gomphus ventricosus Walsh. Ent. soc. Phil. Proc. 2:249

1875 Gomphus ventricosus Hagen, Bost. soc. nat. hist. Proc. 18:47 (listed)

1900 Gomphus ventricosus Williamson, Dragon flies Ind. p. 287 (description and figure)

This apparently rare species has not yet been taken in New York. I include it in this list because of its occurrence in Illinois and Massachusetts; it will doubtless yet be found within the state. Its nymph is unknown.

Gomphus amnicola Walsh

1862 Gomphus amnicola Walsh, Acad. nat. sci. Phil. Proc. p. 396

1863 Gomphus amnicola Walsh, Ent. soc. Phil. Proc. 2:256 (note)

1897 Gomphus amnicola Calvert, N. Y. ent. soc. Jour. 5:95 (listed from Bethlehem N. Y.)

1900 Gomphus amnicola Williamson, Dragon flies Ind. p. 294 (description and figure)

Another species which is apparently rare, once collected within the state by Dr Lintner at Bethlehem. The nymph is unknown.

Gomphus scudderi Selys

1878 Gomphus scudderi Selys, Acad. Belg. (2) Bul. 46:460 ♀

1898 Gomphus scudderi Harvey, Ent. news, 9:62–63 ♂ (description and figures)

This handsome black species (pl. 17, fig. 2), unique in the yellow basal rings on its abdominal segments, has not been reported hitherto

from this state. It was common at Saranac Inn, and even more common, judging by the numbers of exuviae in evidence along the bank, at Axton along Stony brook. But few imagos were seen at large, but many were bred from nymphs taken from Little Clear creek beside the hatchery.

This species, unlike most Odonata, seems to prefer daylight, and even midday as a time for transformation. The boarded banks of the impounded creek beside the hatchery were watched through the entire season, and each day the exuviae left there were gathered. Rarely were any fresh skins found there early in the morning. July was so rainy there was comparatively little time suitable for transformation; and, when the clouds would break away about noon and the sun shine out, I could be sure, on going out, to find some nymphs in transformation. On the few clear days, this was most often observed about noon. All the skins observed were left 3–30 inches above the surface of the water. The nymphs are rather slow and sprawling. The imagos seem to spend little time in flight, preferring to rest on timbers about the rapids of the stream.

Nymph. (Pl. 18, fig. 2) Measures in total length 42 mm; abdomen 28 mm; hind femur 5.2 mm; width of head 6.3 mm, of abdomen 8 mm.

Body elongate, depressed, with the long abdomen regularly tapering for half its length; the fringe of hairs on lateral margins very dense and soft; color yellowish brown, darker on the sides of the thorax; eyes black; ocelli yellowish; a double row of trapezoidal blackish spots on the abdomen between the middorsal line and the line of scars each side, each spot with a prolonged external apical angle reaching the apical carina on each segment, the spots on segments 9 and 10 becoming diffused over the sides of the segments; a series of minute, longitudinal yellowish dashes in the apical sutural area of each segment. That so much of color pattern is observable is doubtless due to the fact that these nymphs live in comparatively clean sand.

Abdomen depressed, and with a well marked middorsal impressed line, and no dorsal hooks, save the merest rudiment on the apex of the ninth segment; lateral spines well developed on segments 6–9 (there are tufts of hairs on the latter apical angles of segments before the sixth) increasing a little in size posteriorly, those of the ninth segment closely appressed, and hardly surpassing the base of the tenth segment.

Mentum of labium a third longer than wide; front border of median lobe nearly straight, with a sparse fringe of flattened scale like hairs; lateral lobe strongly incurved at about a right angle beyond the base of the movable hook; about four teeth on the inner margin, increasing a little in size posteriorly.

While nymphs of several sizes were taken together in the creek, they seemed to have a definite period, including hardly more than the month of July, for transforming.

Aug. 2 was the date of the first imago captured at large. June 30 was the date of the first imago bred.

Gomphus vastus Walsh

1862 Gomphus vastus Walsh, Acad. nat. sci. Phil. Proc. p. 391
1875 Gomphus vastus Hagen, Bost. soc. nat. hist. Proc. 18: 47 (listed from New York)
1872 Gomphus vastus Cabot, Mus. compar. zool. Mem. v. 3, pl. 2, fig. 4 (description and figure of nymph)
1885 Gomphus vastus Hagen, Am. ent. soc. Trans. 12; 265–66 (description of nymph)
1890 Aeshna vasta Kirby, Cat. Neur. Odon. p. 66 (listed)
1892 Gomphus vastus Banks, Am. ent. soc. Trans. 19 : 352 (listed)
1893 Gomphus vastus Calvert, Am. ent. soc. Trans. 20: 245 (description)
1895 Gomphus vastus Calvert, N. Y. ent. soc. Jour. 3: 45 (listed from New York)
1899 Gomphus vastus Kellicott, Odon. Ohio, p. 57–58 (description and figure)
1900 Gomphus vastus Williamson, Dragon flies Ind. p. 287 (description and figure)

This striking species frequents the shores of the Great lakes and the larger streams. The nymphs live on the bottom at some depth. In the above bibliography are indicated numerous descriptions and some figures of both nymph and adult. The species may be recognized by the characters stated in the tables.

Gomphus plagiatus Selys

1854 Gomphus plagiatus Selys, Acad. Belg. (2) Bul. 21: 57
1861 Gomphus plagiatus Hagen, Synopsis Neur. N. Am. p. 109
1885 Gomphus plagiatus Hagen, Am. ent. soc. Trans. 12: 269–70 (description of the nymph)
1893 Gomphus plagiatus Calvert, Am. ent. soc. Trans. 20: 244 (description)
1897 Gomphus plagiatus Calvert, N. Y. ent. soc. Jour. 5: 95 (listed from New York)
1899 Gomphus plagiatus Kellicott, Odon. Ohio, p. 69–70 (description and discussion)
1900 Gomphus plagiatus Williamson, Dragon flies Ind. p. 295–96 (description and figure)

A very large species, apparently commonest about broad marshy tracts, taken but once as yet in this state. It will be easily recognized by the characters stated in the tables.

Gomphus spiniceps Walsh

1862 ?Macrogomphus spiniceps Walsh, Acad. nat. sci. Phil. Proc. p. 389
1854 Gomphus spiniceps Selys, Acad. Belg. (2) Bul. 21: 57

1885 Gomphus spiniceps Hagen, Am. ent. soc. Trans. 12:270–71 (description of nymph)
1899 Gomphus spiniceps Kellicott, Odon. Ohio, p. 69 (description and figure)
1900 Gomphus spiniceps Williamson, Dragon flies Ind. p. 295 (description and figure)

A strong flying species, frequenting rapid streams. Transforms in midsummer, and appears in flight and ovipositing late in the summer or early in autumn. "Observed flying late in the afternoon, and ovipositing in a small brook that was rippling over pebbles." Kellicott (*loc. cit.*) The species has not been recorded from this state hitherto, but there are New York specimens in the Museum of comparative zoology, and the species has long been known from Illinois and Massachusetts.

Gomphus spicatus Hagen

1854 Gomphus spicatus Hagen, Acad. Belg. (2) Bul. 21:54
1861 Gomphus spicatus Hagen, Synopsis Neur. N. Am. p. 107
1875 Gomphus spicatus Hagen, Bost. soc. nat. hist. Proc. 18:47 (listed; distribution given)
1890 Aeshna spicata Kirby, Cat. Neur. Odon. p. 64 (listed: bibliography)
1892 Gomphus spicatus Banks, Am. ent. soc. Trans. 19:353 (listed)
1895 Gomphus spicatus Calvert, N. Y. ent. soc. Jour. 3:45 (listed)
1897 Gomphus spicatus Van Duzee, N. Y. ent. soc. Jour. 5:89 (listed from Clarence)
1897 Gomphus spicatus Calvert, N. Y. ent. soc. Jour. 5:93 (listed from Clarence)
1899 Gomphus spicatus Kellicott, Odon. Ohio, p. 97–98 (description and figure)
1900 Gomphus spicatus Williamson, Dragon flies Ind. p. 292 (description and figure)

This is a common species in the northeastern United States, ranging from Illinois eastward; it is more generally distributed throughout its range than are most gomphines. Next to G. exilis it was the commonest Gomphus at Saranac Inn, where it frequented all sorts of waters. Imagos were common during the latter part of June and the first two weeks of July along the wagon road and railroad between Little Clear and Big Clear creeks; they were foraging there, and, while a little shy and wary, were not very difficult to catch with a net.

Nymph. Total length 31 mm; abdomen 20 mm; hind femur 6.2 mm; width of head 5 mm, of abdomen 7 mm.

Body elongate, somewhat depressed; abdomen lanceolate, pointed.

Color dark brownish, with some black marks on the sides of the thorax; margins of the abdominal segments darker; a pair of black dots on the dorsum of each of the middle abdominal segments.

Dorsal hooks of abdomen represented only by minute backward prolongations of the median ridge on all the segments; lateral spines on segments 7–9, increasing in size posteriorly, small, on the ninth segment much shorter than the 10th segment, against which they are closely appressed; 10th segment two thirds as long as the eighth, and a little less than half as long as the ninth.

Labium with its median lobe distinctly convex anteriorly, and with a brown tooth in the middle in the midst of the usual flat, fringing hairs; lateral lobe regularly arcuate, with about nine coarse, trapezoidal, serrately recurved teeth on its inner margin.

A goodly number of specimens of the nymphs were collected from Little Clear creek on the hatchery grounds, Little Clear pond near its outlet, and from Bone pond.

Gomphus villosipes Selys

1854 Gomphus villosipes Selys, Acad. Belg. (2) Bul. 21:53
1861 Gomphus villosipes Hagen, Synopsis Neur. N. Am. p. 105
1890 Aeshna villosipes Kirby, Cat. Neur. Odon. p. 64 (bibliography)
1893 Gomphus villosipes Calvert, Am. ent. soc. Trans. 20:244–45 (description)
1894 Gomphus villosipes Banks, Can. ent. 26:77 (listed from Ithaca)
1895 Gomphus villosipes Calvert, N. Y. ent. soc. Jour. 3:45 (listed from Ithaca)
1897 Gomphus villosipes Van Duzee, N. Y. ent. soc. Jour. 5:89 (listed from Grand Island)
1897 Gomphus villosipes Calvert, N. Y. ent. soc. Jour. 5:93 (listed from Grand Island)
1897 Gomphus villosipes Needham, Can. ent. 29:166 (note on rearing the nymph at Ithaca)
1899 Gomphus villosipes Kellicott, Odon. Ohio, p. 63 (description and figure)
1900 Gomphus villosipes Williamson, Dragon flies Ind. p. 291

This is an exceedingly common species at Ithaca, where I have picked up thousands of the exuviae at a time along the borders of the Cascade pond in June. The imagos fly about or rest on the snags and projecting rocks, which are common in the turbulent creeks about Ithaca. The nymphs burrow in the bottom in shallow water, seeming to prefer banks of somewhat clayey mud. They are slow moving, stiffly sprawling creatures, powerful, rapacious, and seemingly the dominant animals in the bottom mire.

Nymph. Total length 35 mm; abdomen 23 mm; hind femur 7.5 mm; width of head 6 mm, of abdomen 8.5 mm.

Body depressed, with legs wide apart and very sprawling; abdomen lanceolate, pointed, rapidly narrowed beyond the fifth to the base of the ninth segment, more slowly narrowed thereafter. The whole body and all appendages, clothed with a dense scurfy pubescence, which is conspicuously marked with bare lines or "scars."

Abdomen with obtuse, continuous middorsal ridge, showing no trace of dorsal hooks; lateral spines very small, closely appressed, and inconspicuous, present only on segments 8 and 9, on 8 very short, on 9 longer, but closely applied to the sides of segment 10. The 10th segment is hardly shorter than the eighth, but it is less than half as long as the ninth.

The mentum of the labium is distinctly produced and rounded on its front border, with a median brown tooth in the midst of the fringing flat hairs. The lateral lobe is broad and strongly arched, with about six coarsely serrate teeth on its inner margin.

Gomphus furcifer Hagen

1878 Gomphus furcifer Hagen, Acad. Belg. (2) Bul. 46:458
1899 Gomphus furcifer Kellicott, Odon. Ohio, p. 64 (description and figure)
1900 Gomphus furcifer Williamson, Dragon flies Ind. p. 292 (description and figure)

This species has not hitherto been recorded from New York state, and I have not seen it there at large; but there is a specimen bearing an Ithaca label in the Cornell university collection. The nymph is unknown.

DROMOGOMPHUS

A single species of this genus belongs to the New York fauna.

Dromogomphus spinosus Selys

1854 Gomphus spinosus Selys, Acad. Belg. (2) Bul. 21:59
1861 Gomphus spinosus Hagen, Synopsis Neur. N. Am. p. 102
1862 Gomphus spinosus Walsh, Acad. nat. sci. Phil. Proc. p. 391 (note)
1863 Gomphus spinosus Hagen, Stett. ent. zeit. 24:373
1873 Gomphus spinosus Hagen, Bost. soc. nat. hist. Proc. 16:359
1875 Gomphus spinosus Hagen, Bost. soc. nat. hist. Proc. 18:44 (bibliography)
1893 Dromogomphus spinosus Calvert, Am. ent. soc. Trans. 20:245 (description)
1894 Dromogomphus spinosus Banks, Can. ent. 26:77 (listed from Ithaca and Baldwinsville)
1895 Dromogomphus spinosus Calvert, N. Y. ent. soc. Jour. 3:45 (listed from Ithaca and Baldwinsville)
1897 Dromogomphus spinosus Calvert, N. Y. ent. soc. Jour. 5:93 (listed from Karner)
1897 Dromogomphus spinosus Needham, Can. ent. 29:186 (characters of the nymph)
1899 Dromogomphus spinosus Kellicott, Odon. Ohio, p. 71 (description)
1900 Dromogomphus spinosus Williamson, Dragon flies Ind. p. 296 (description)

This species has been taken sparingly and in a few places within the state, but it is probable that it frequents the borders of most of the larger

bodies of water. Prof. Herrick of the Agricultural college of Mississippi found it transforming abundantly on the shore of Canandaigua lake at the natural science camp in June 1897. I have found it at Ithaca and at Saranac Inn; at the latter place only in Little Clear pond, near the outlet. That was during the week which included June 30. The nymphs were crawling up out of rather deep water on stumps and logs on the bank to transform.

A big pine stump that stood partly in the water, halfway between the outlet and the cold water pipe, seemed a favorite place of transformation. It was fairly dotted over with exuviae, most of which were several feet above the water. No imagos were seen, excepting the few that were bred.

Nymph. (Pl. 18, fig. 1) Total length 33 mm; abdomen 22 mm; hind femur 7 mm; width of head 6 mm, of abdomen 7 mm.

Body elongate, little depressed, little hairy; color dirty brownish, becoming clear brown on the apex of the abdomen; some darker markings on the sides of the thorax and at the lateral margins of the abdomen, and across the base of the dorsum of the middle abdominal segments.

Head cordate in outline, the hind margin being broadly emarginate; antennae long, considerably surpassing the tip of the labrum, and upturned beyond the end of it; first segment twice as large as the second, both globular; third segment narrowly cylindric, more than twice as long as the two basal ones together, bearing the minute, rudimentary, globular, fourth segment on its upturned tip; burrowing hooks well developed.

Abdomen narrowed beyond the sixth segment rather regularly; dorsal hook on segments 2–9 regularly increasing in size and sharpness, and regularly increasingly declined posteriorly, that on segment 9 being a direct continuation of the sharp middorsal ridge of the segment, black tipped, lateral spines on segments 6–9 increasing in size posteriorly, those of the ninth segment reaching the level of the middle of the 10th segment; the eighth segment is a third longer than the 10th; the ninth segment is two and one half times as long as the 10th; the superior and inferior appendages are somewhat longer than the 10th segment, but the laterals are about equal to it, being about one fourth shorter than the other appendages.

The mentum of the labium is rather regularly widened anteriorly, with a straight front border; lateral lobes strongly arcuate, with end hook distinctly more prominent than the nine or ten coarse, angulately serrate teeth before it on the inner margin.

Subfamily AESCHNINAE

This group includes the largest, fleetest, and most voracious of our dragon flies. Many of them are common and very well known. Most of the species are marked with bright blues and greens. They roam far from water, and often find their way into houses in warm weather. Several species are commonly seen coursing over lawns in the evening twilight.

The nymphs are known for a larger proportion of the genera than in any other subfamily. They are climbers among green plants, over timbers, on swaying roots, etc., preferring the border of open water or the edge of a current. They are slender, active, clean, with smooth bodies marked with a color pattern of greens and browns, well adapted to concealment in the midst of their natural environment. They will eat almost any living animal that they can capture and hold, and they eat one another with evident relish.

The nymphs agree in the possession of the following characters: Head depressed; antennae (when grown) six to seven-jointed, filiform; eyes large, very prominent, covering the anterolateral angles of the head; labium very long, reaching between the bases of the middle legs, mentum flat, not covering the face, median lobe with a minute median cleft, lateral lobe denticulate on inner side, and with a terminal hook, as well as the usual movable hook; legs slender, fitted for climbing and clinging; tarsi three-jointed; prothorax with a transverse, dorsal, flattened area, and a pair of conic processes above each coxa; spiracles large, conspicuous; abdomen somewhat spindle-shaped, with lateral margins becoming acute posteriorly; lateral spines present on a variable number of the segments; inferior abdominal appendages at least twice as long as the lateral appendages.

The following tables will enable any one to distinguish the members of our few genera.

KEY TO GENERA

Imagos

a The radial sector (Rs., fig. 9) simple

b But two cubito-anal cross veins; vein M_2 undulate; supratriangle without cross veins; but one cross vein under the stigma..Gomphaeschna

bb With three or more cubito-anal cross veins; vein M_2 not undulate; supratriangle divided by cross veins; several cross veins under the stigma

c Basal space traversed by cross veins.....Boyeria

cc Basal space open .....Basiaeschna

aa Radial sector bearing an apical fork

b Sectors of the arculus (veins M_{1-3} and M_4) separating from the arculus at or below its middle

c The radial sector symmetrically forked, between it and the supplementary vein below it, one or two rows of cells

d Face strongly produced above, the upper margin of the frons very acute; the veins M_1 and M_2 parallel to the level of the stigma; radial sector and the supplementary vein below it separated by a single row of cells Nasiaeschna

dd Face vertical, not sharply angulate at upper edge of frons; veins M_1 and M_2 approximated at the stigma; the radial sector and the supplementary vein below it separated by two rows of cells Epiaeschna

cc The radial sector strongly deflected toward the stigma at the base of its fork, unsymmetric; between it and the supplementary vein below it, three to seven rows of cells .....Aeschna

bb Sectors of the arculus springing from above the middle of the arculus.Anax

Nymphs

These are known for all the foregoing genera except Gomphaeschna: the nymphs figured and described by Cabot and referred by supposition to that genus, were the males of Boyeria (see below under the account of that genus). Among all our nymphs that are still unknown, that of Gomphaeschna remains one of the most desirable discoveries yet to be made.

a Hind angles of the head viewed from above, sharply angulate
b Lateral lobe of labium squarely truncate on apex.....Boyeria
bb Lateral lobe of labium with taper-pointed apex .....Basiaeschna
aa Hind angles of the head obtusely rounded
b With lateral spines on abdominal segments 4–, 5–, or 6–9.
c With lateral spines on segments 4–, or 5–9
d With dorsal hooks on abdominal segments 7–9.....Nasiaeschna
dd With no dorsal hooks on abdomen.....Epiaeschna
cc With lateral spines on abdominal segments 6–9.....Aeschna
bb With lateral spines on abdominal segments 7–9.....Anax

So well marked are these genera that their nymphs may be recognized by the following

Single distinctive characters

Nasiaeschna alone has dorsal hooks on the abdomen.
Basiaeschna alone has the apices of its lateral labial lobes pointed.
Anax alone has lateral spines on abdominal segments 7–9 only.
Aeschna alone has lateral spines on abdominal segments 6–9 only.
Boyeria alone has two teeth on the front border of the median lobe of the labium, at a distance either side from the median cleft.
Epiaeschna alone is lacking in all the above characters.

GOMPHAESCHNA

The single regional species G. furcillata Say has not been taken as yet within this state, so far as records show. Its nymph is unknown, that one referred to this species by Cabot on supposition proving to be the male nymph of Boyeria, described below.

BOYERIA

This genus includes the single North American species.

Boyeria vinosa *Say*

1839 Aeschna vinosa Say, Acad. nat. sci. Phil. Jour. 8:13
1839 Aeschna 4-guttata Burmeister, Handb. ent. 2:837
1861 Aeschna 4-guttata Hagen, Synopsis Neur. N. Am. p. 130
1875 Neuraeschna vinosa Hagen, Bost. soc. nat. hist. Proc. 18:37 (full bibliography and distribution)

1892 Aeschna vinosa Banks, Am. ent. soc. Trans. 19:353 (listed from New York)

1893 Fonscolombia vinosa Calvert, Am. ent. soc. Trans. 20:247 (description)

1895–97 Fonscolombia vinosa Calvert, N. Y. ent. soc. Jour. 3:45 and 5:93 (listed from Keeseville, Ithaca, Schoharie, Piseco lake, Elk lake, Colden, and Westchester co.)

1899 Fonscolombia vinosa Kellicott, Odon. Ohio, p. 90 (description)

1900 Boyeria vinosa Williamson, Dragon flies Ind. p. 300–1 (description)

1881 Neuraeschna vinosa Cabot, (Nymph) Mus. compar. zool. Mem. 8:29, 39, pl. 2, fig. 3

This interesting species, which seems likely to be found inhabiting almost every woodland creek in the state, was very common at Saranac Inn in Little Clear creek, and in the borders of the pond above. The nymphs were transforming commonly on the sides of timbers in the edge of the water from the beginning of our session till the latter end of July. A number of both sexes were reared in our cages. A few imagos might be seen, specially afternoons in favorable weather from midsummer till the end of our session, about the creek on the hatchery grounds. They glide along above the stream, not very rapidly, on well poised, transparent wings, which against the background of the water are well nigh invisible. The two big round yellow spots on each side of the thorax distinguish this species from all its kin, even while in flight.

The nymphs, which are generally quite dark colored, seem to prefer timbers, trailing roots, driftwood, etc., as a foraging ground. I have rarely taken them from green vegetation.

Nymph. Total length ♂ 33, ♀ 36 mm; abdomen, ♂ 22.5, ♀ 25 mm; hind femur 5.5 mm; width of head 7 mm, of abdomen 7.5 mm.

Body elongate, slender, smooth; color blackish brown, obscurely marked with paler in transverse rings on the legs, and in dashes, tending to become arranged in interrupted, longitudinal rows on the abdomen.

Head concave behind, with truncated hind angles; sides straight, diverging strongly anteriorly to meet the very prominent eyes; labium moderate; middle third of front margin of median lobe straight, with a tooth at each side remote from the median cleft.

Abdomen widest across the fifth and sixth segments, tapering unequally to the ends; no dorsal hooks; lateral spines on segments 5–9, on 5 small, on 6–9 conspicuous, increasing a little in size posteriorly, those of the ninth segment three fourths as long as the 10th segment; the abdominal segments are longest in the middle, and decrease a little toward both ends; the appendages are longer than the last two segments together, and differ in the two sexes in the form of the apex of the superior appendage; in the ♂ this has a distinct narrow apical cleft, in the ♀ the cleft is closed when grown; in small female nymphs, however, I have seen it quite as widely open and as distinct as in the male: in both sexes

the laterals are one fourth as long, and the superiors eight ninths as long as the inferiors.

Some smaller nymphs from the creek show a middorsal black band on the abdomen, divided by a median row of small yellow spots, largest on the eighth segment.

Basiaeschna janata Say

1839 Aeschna janata Say, Acad. nat. sci. Phil. Jour. 8:13
1842 Aeschna minor Rambur, Ins. Neur. p. 207
1861 Aeschna janata Hagen, Synopsis Neur. N. Am. p. 125
1875 Aeschna janata Hagen, Bost. soc. nat. hist. Proc. 18:33 (full bibliography and distribution)
1895 Basiaeschna janata Calvert, N. Y. ent. soc. Jour. 3:45 (listed from Keeseville)
1899 Basiaeschna janata Kellicott, Odon. Ohio, p. 81 (description)
1900 Basiaeschna janata Williamson, Dragon flies Ind. p. 301 (description)

This species is perhaps the earliest of the Aeschninae. It was common about the hatchery grounds on our arrival, and had about disappeared by midsummer. I got mostly immature nymphs at Saranac Inn, but I bred the species abundantly at Ithaca several years ago. I saw females ovipositing several times during the first week of our stay at Saranac Inn, and watched the process once in detail. In each instance observed the eggs were deposited in leaves of a species of bur-reed, Sparganium, which, where it grew in the deeper water of the creek, trailed its long leaves on the surface of the stream. The female flitted from plant to plant, making a few thrusts with her ovipositor into each at the water line, and then settled and balanced herself carefully on a long, floating leaf; this was doubtless a most favorable place for the eggs, and she settled down to more extensive operations. Backing down into the water till the abdomen was wholly submerged, she began thrusting with her ovipositor, first to right and then to left, moving forward a little between thrusts, leaving behind a double row of egg punctures, as regular as the neatest double stitching that might be done with a needle. Several such double rows of eggs were placed in the tissues of this leaf before she left it. The leaf was found to be thickly covered on the under side (as all submerged surfaces were covered in the creek at that time) with hundreds of red hydras, in all stages of budding. I placed the leaf in a hatchery trough, where the hydras remained in good condition till after the hatching of the eggs.

Nymph. Total length 43 mm; abdomen 30 mm; hind femur 6 mm; width of head 7.5 mm; of abdomen 8 mm.

Body elongate, slender, nearly smooth; color brownish black, with paler rings on the femora and tibiae, three or four rings on each; pale

marks on the lateral margins of the abdominal segments at base; a broad middorsal pale band on abdomen, mottled with brown, and including two blackish spots on the eighth segment; appendages, spines, tarsal segments and claws, yellow, blacktipped.

Head with very prominent, anteriorly directed eyes, narrowed behind the eyes to very sharp hind angles; between these angles the rear of the head is slightly concave; the labium has its median lobe prominent, fringed, distinctly cleft; the lateral lobe, rather small, tapering to its incurved apex, rather regularly.

Abdomen without dorsal hooks, with lateral spines on segments 3 or 4–9, increasing in size posteriorly, those of the ninth segment about equaling in length the 10th segment; inferior appendages long and very sharp, distinctly longer than the last two abdominal segments; superior one half to three fifths as long as the inferiors, its apex with a round notch; laterals about half as long as the superior.

The unusual brevity of the superior appendage is about as distinctive as the shape of the lateral labial lobe, indicated in the above table.

NASIAESCHNA[1]

There is a single species.

Nasiaeschna pentacantha Rambur

1842 Aeschna pentacantha Rambur, Ins. Neur. p. 208

1861 Aeschna pentacantha Hagen, Synopsis Neur. N. Am. p. 129 (description)

1862 Aeschna pentacantha Walsh, Acad. nat. sci. Phil. p. 397 (notes)

1875 Aeschna pentacantha Hagen, Bost. soc. nat. hist. Proc. 18:37 (bibliography and distribution)

1888 Epiaeschna heros (nymph) Garman, Ill. state lab. nat. hist. Bul. 3:178 (descriptive notes)

1895 Aeschna pentacantha Banks, Ent. news, 6:124 (recorded from Baldwinsville)

1897 Aeschna pentacantha Calvert, N. Y. ent. soc. Jour. 5:95 (recorded from Baldwinsville)

1900 Aeschna pentacantha Williamson, Dragon flies Ind. p. 305 (description)

This species ranges from Massachusetts to Texas, and from Illinois to Georgia: it is apparently rare throughout its range. Probably not more than a dozen specimens of the adult insect exist in collections.

As to the nymph, Garman first found it in the Mississippi bottoms near Quincy Ill. His types were lent me for study several years ago by Prof. Forbes. I was able to refer them by exclusion to this species. Mr Hart of the Illinois state laboratory, has since written me that he has successfully reared similar nymphs obtained by him in a creek near Champaign Ill. Thus their identity is settled. I have since obtained well

1 de Selys 1900: diagnosis in French, included in a paper "Odonaten aus Neu-Guinea" by F. Förster, in *Termeszetrajzi Füzetek*, v. 23 (Budapest).

grown nymphs from Moline Ill. Two imagos taken by Prof. R. H. Pettit at Baldwinsville, Onondaga co., constitute the only record of the species for this state.

Nymph. (The largest I have before me, not grown, as shown by the shortness of the wing cases.) Measures 24 mm; abdomen 16 mm; hind femur 4 mm; width of head 5.5 mm, of abdomen 6 mm.

Color blackish, labium and tarsi yellowish; body rough granulate, but not hairy, with paired tubercles obtuse above the base of the antennae, and on the middle of the vertex, and on the middle of the superolateral ridge that extends from the rear of the eyes to the hind angles of the head; a pair also on the superolateral angles of the prothorax; and the usual two pairs above the bases of the coxae, the anterior a little longer and stouter, but both directed anteriorly; three or four pairs above the middle and hind coxae, running down into a ridge which extends on these coxae; a dorsal, tuberculate, superior ridge on all the femora; dorsal hooks represented on all the segments of the abdomen, becoming prominent and pointed on segments 6–9; lateral spines on segments 5–9, increasing in length posteriorly, those of the ninth segment, two thirds as long as the 10th segment; appendages more than twice as long as the 10th segment, superior and inferiors of equal length, laterals one fourth to one fifth as long as the others, superior, obtuse at tip, inferiors finely denticulate exteriorly.

Head considerably narrowed behind the eyes, and with a deep, quadrangular excavation of the hind margin; eyes with a very long anterior border, and a long pointed hind angle lying on the vertex; labium with the cleft of the median lobe somewhat v-shaped, not closed; lateral lobe truncate on apex, with about 18 denticles on inner margin.

EPIAESCHNA

There is a single North American species.

Epiaeschna heros Fabricius

1798 Aeshna heros Fabricius, Ent. syst. Suppl. p. 285
1839 Aeshna multicincta Say, Acad. nat. sci. Phil. Jour. 8:9
1861 Aeschna heros Hagen, Synopsis Neur. N. Am. p. 128
1869 Aeschna heros Harris, Ent. correspondence. p. 326 (notes)
1862 Aeschna heros Walsh, Acad. nat. sci. Phil. Proc. p. 397 (notes)
1875 Aeschna heros Hagen, Bost. soc. nat. hist. Proc. 18:36 (bibliography and distribution)
1881 Epiaeschna heros (nymph) Cabot, Mus. comp. zool., Mem. 8:30, 39, pl. 1, fig. 3
1893 Epiaeschna heros Calvert, Am. ent. soc. Trans. 20:246–47 (description)
1895–97 Epiaeschna heros Calvert, N. Y. ent. soc. Jour. 345; 5:93 (listed from Dobbs Ferry, New York, Ithaca, Albany and Buffalo)
1899 Epiaeschna heros Kellicott, Odon. Ohio, p. 81 (description)
1900 Epiaeschna heros Williamson, Dragon flies Ind. p. 302 (description)

This, our largest dragon fly, is widely distributed throughout the state, and, for that matter, throughout the whole eastern United States. Its

strikingly large size, and its habit of flying into houses not unfrequently, and its apparent migrations in numbers, have made it a rather well known species.

Since the nymph has been described and figured by Cabot, it will suffice here to give a brief statement of its more distinctive characters.

Nymph. Apparently full grown, measures in total length 46 mm; abdomen 32 mm; hind femur 7.5 mm; width of head 10 mm, of abdomen 10 mm.

Body very elongate, widest across the eyes and the seventh and eighth abdominal segments. Head flat, much narrowed behind the eyes, with a deep, well rounded concavity on the hind margin, and obtuse hind angles; labium long extending posteriorly between the bases of the middle legs; mentum (fig. 13) with sides parallel for half its length, then suddenly widened in a regular curve to the bases of the lateral lobes; median lobe with convex front border divided by a shallow open cleft, bearing a fringe of short scales on either side of the cleft; lateral lobe truncate on tip with a short hook on inner angle at tip, before which are some 12 to 15 denticles.

Fig. 13 Labium of Epiaeschna heros Fabr., from within. Photo by J. G. Needham

Abdomen with an obtuse middorsal ridge; lateral spines on segments 5–9, increasing in size posteriorly, on 9 hardly longer than half of the length of the 10th segment, but broadly triangular; superior appendage almost as long as the inferiors, not cleft at apex; laterals half as long, inferiors not quite as long as segments 9 and 10 together.

AESCHNA

Three closely related species of this genus are known from the state. Male imagos of these species may be separated by the following key.

KEY TO SPECIES OF AESCHNA

a Anal triangle of hind wing of male consisting usually of three cells. Superior abdominal appendages of male with a prominent inferior spine at the distal end; genital valve of female strongly elevated at the apex .. constricta

aa Anal triangle of the hind wing of the male consisting generally of two cells; superior appendage of the male without prominent inferior spine; genital valve of female not strongly elevated at its apex

b Superior abdominal appendages of the male with a superior longitudinal carina denticulated ..... clepsydra

bb Superior appendages of the male with the superior longitudinal carina not denticulated ..... verticalis

I am not able to distinguish between the nymphs of these species. Constricta and clepsydra were both common at Saranac Inn during the latter half of the summer. I collected many nymphs, and it would seem likely that I should have both species; but I have found hitherto no specific differences between them. The imagos of the three species are similar in habits and are often found flying together. It is probable that the nymphs are likewise similar in habits. The nymph of Aeschna constricta is described and figured by Cabot[1]. Descriptions of these three species will be found in the monographs of Calvert, Kellicott and Williamson, frequently cited in the preceding bibliographies of species. Under these circumstances it seems unnecessary to enter into a detailed discussion of them. It will suffice, for the certain recognition of nymphs of the genus, to restate the chief characters of the nymph of A. constricta, a species which I have bred abundantly at Ithaca and at Saranac Inn.

Nymph. Fully grown measures in total length 43 mm, abdomen 31 mm, hind femur 6.5 mm; width of head 7.5 mm, of abdomen 7.5 mm.

Body elongate, graceful, active; color varied green and brown, the amount of either color varying to agree with environment, the paler markings of the dorsum generally tending to form longitudinal interrupted streaks.

Head with prominent, well-rounded eyes, whose hind angles almost meet on the vertex; rear of head hardly convex posteriorly; hind angles broadly rounded; labium moderately widened in distal half of mentum; middle lobe with closed median cleft; lateral lobe squarely truncate on end, denticulate within.

Abdomen widest in the middle, where the segments are also longest; lateral spines on segments 6–9, on 6 minute, on 9 a little longer than half the length of the 10th segment; inferior appendages longer than segments 9 and 10; the deeply notched superior appendage three fourths as long as the inferiors, the laterals one half as long as the inferiors and with very sharp, incurvate points.

ANAX

The single species discussed below properly belongs to our fauna: another tropical species, Anax longipes is occasionally picked up on our Atlantic coast.

1773 Libellula junia Drury, Illus. exotic ent. v. 1, pl. 47, fig. 5n

1842 Aeschna spiniferus Rambur, Ins. Neur. p. 186, pl. 1, fig. 14

1854 —— —— Emmons, Agric. N. Y. v. 5, pl. 15, fig. 3 (colored figure of the male; no description; no name)

1861 Anax junius Hagen, Synopsis Neur. N. Am. p. 118

1875 Anax junius Hagen, Bost. soc. nat. hist. Proc. 18: 32 (full bibliography and distribution)

[1] Immature state of the Odonata. 1881. pt 2.

1890 Anax junius Hagen, Psyche, 5 : 305 (critical account of the species)
1893 Anax junius Calvert, Am. ent. soc. Trans. 20 : 249 (description)
1897 Anax junius Calvert, N. Y. ent. soc. Jour. 3 : 46 and 5 : 93 (listed from New York, Ithaca, Schoharie and Buffalo)
1899 Anax junius Kellicott, Odon. Ohio, p. 77
1900 Anax junius Williamson, Dragon flies Ind. p. 306
1881 Anax junius Cabot, (nymph) Mus. comp. zool. Mem. 8 : 15, 36, pl. 1, fig. 2

Anax junius Drury

This well known species, which is very common in most parts of the state, was rather rare at Saranac Inn. A single nymph was taken from the little bog pond on the inn wagon road, and a single male imago was observed flying over the same pond. Elsewhere the imagos are on the wing from March till November; they fly from daylight to dark, and are fleet, powerful and fearless.

The female in ovipositing is often held by the male, specially in early spring, often is unattended, and sometimes descends bodily into the water. In early spring the eggs are inserted in the water-soaked stems of reeds, in floating sticks, etc.; later in the season they are placed in the tissues of green and growing aquatic plants.

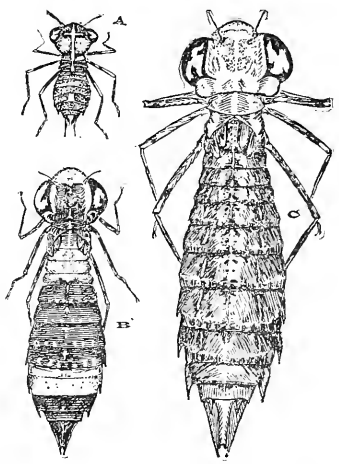

Fig. 14 Early stages of nymph of Anax junius Dru., showing changes of color pattern A, newly hatched; B, one fourth grown; C, one half grown

The nymph of this species is probably better known than that of any other. It is sure to get into the net of the aquatic collector. It clings to water weeds nearer the surface, usually, than the bottom, in an attitude of alertness, with head poised low and abdomen slightly elevated. Locomotion is relatively rapid, either by walking, or by swimming by ejections of water from the respiratory chamber. It is a notoriously cannibalistic species: among abundant and choice food, the larger nymphs will eat the smaller ones, and two of equal size can not be safely kept together in close quarters.

Cabot[1] has figured and described the nymph, and many indifferent reproductions of his figure are current. The following brief diagnostic statement of its principal characters will serve for its recognition.

Nymph. (fig. 14) Measures in total length 39 mm; abdomen 29 mm; hind femur 8 mm; width of head 8 mm, of abdomen 8.4 mm.

[1] Immature state of the Odonata. 1881. pt 2.

Body slender, smooth; colors brown and green, in a pattern of longitudinal streaks, well adapted to concealment among plant stems, the depth of the color varying to suit the environment.

Head strongly depressed, with the eyes covering the greater part of the sides of it; labium very long, reaching posteriorly the base of the hind legs; the mentum regularly widened from base to apex, produced median lobe with a closed median cleft; lateral lobe suddenly rounded off at end to the incurved internal end hook, but hardly truncate; legs long and slender as befits its climbing habits, tibiae and femora faintly ringed with brown; abdomen with strong and evident lateral spines on segments 7-9 only; superior abdominal appendage with a well rounded apical notch, its length about seven eighths that of the inferiors, which are longer than segments 9 and 10 together; lateral appendages two fifths as long as the inferiors; spines of the ninth segment about as long as the 10th segment.

Subfamily PETALURINAE

There is but one genus and species occurring in the eastern United States: both will be recognized by the characters given in the table for major groups.

Tachopteryx thoreyi Selys

1857 Uropetala thoreyi Selys, Monographie des gomphines, p. 373 (♂)
1861 Petalura thoreyi Hagen, Synopsis Neur. N. Am. p. 117
1878 Tachopteryx thoreyi Selys, Acad. Belg. (2) Bul. 46: 696 (♀)
1893 Tachopteryx thoreyi Calvert, Am. ent. soc. Trans. 20: 241 (description)
1900 Tachopteryx thoreyi Williamson, Ent. news, 11: 398-99 (habits)
1900 Tachopteryx thoreyi Williamson, Dragon flies Ind. p. 281 (description)

This species, originally described from a single male specimen taken in the vicinity of New York, has apparently not been found in the state since that time. It is now known to be distributed from Massachusetts to Florida and Texas. According to Mr Williamson, who has published the little that is known concerning its habits, it flies in Pennsylvania during the whole of June and the first half of July. It is "usually observed resting in sunny situations on fences or trees, at the edges of woodland ... stream and small marshy area near ... Easily approached ... once aroused, its flight is swift and strong."

On June 4, 1900 D. A. Atkinson took in transformation a single female nymph of this species near Pittsburg Pa. E. B. Williamson described and figured this nymph in *Entomological news*. 1901. 12: 1–3, pl 1, and then very kindly loaned me the specimen for study. From this specimen I have drawn the labium and antenna shown in figure 15 and the brief statement of characters given herewith.

Nymph. Length 38 mm.

Antennae 7-jointed, depressed, hairy on lateral margins, the segments short and broad.

Labium short and stout, median lobe with a narrow median cleft and denticulate margin; lateral lobes truncate on end, scarcely denticulate: no raptorial setae.

Legs stout, with prominent, twisted, hair-fringed, longitudinal carinae; tarsi 3-3-3 jointed.

Wing cases laid parallel along the back, their apices reaching the middle of the fifth segment.

Abdomen tapering beyond the fifth segment with thin flaring lateral margins showing on each of segments 4–9 an angle at the middle and a flat tooth at the apex, and with a dorsal row of hairy tubercles on segments 5–9, parallel to the lateral margin but nearer the median line: appendages obtuse, the superior with a broad, shallow, apical emargination.

The eggs are deposited in wet, boggy places, when there is hardly any water standing, and the nymph lives in the mud in such places.

Subfamily CORDULEGASTERINAE

A small group of large species, inhabiting mainly clear streams that flow through upland marshes, spring bogs, etc. The imagos are strong of flight, and are oftenest seen coursing back and forth over some small stream, flying on a regular beat, and passing and repassing the same point at intervals of a few minutes. The collector may take advantage of this habit, and so station himself that he may reach the specimen as it passes, and capture it, if dextrous with a net.

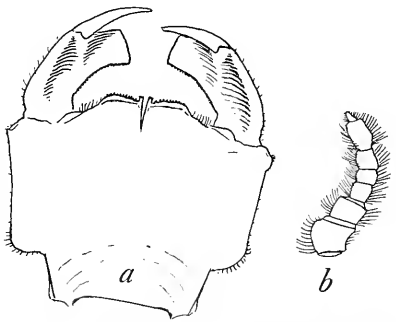

Fig. 15 Tachopteryx thoreyi Selys; *a* labium and *b* antenna of a female nymph (Mr Williamson's type)

The nymphs live on the bottom in shallow water, buried in clean sand or in vegetable silt. Though buried they do not burrow, but descend by raking the sand from beneath them by sweeping, lateral movements of the legs. When deep enough, they kick the sand up over the back till only the elevated tips of the eyes and the respiratory aperture at the tip of the abdomen are exposed. By placing a live nymph in a dish of sand and water and watching, its method may be observed in a very few minutes. The whole comical performance reminds one strongly of the descent of an old hen in a dustbath.

Once adjusted in the sand, a nymph (unless food tempts) remains motionless a very long time. In a dish of sand on my table, I have had a nymph remain without change of position for weeks, no food being offered it. Let any little insect walk or swim near the nymph's head,

and a hidden labium springs from the sand with a mighty sweep and clutches it. I fed to a nymph of Cordulegaster diastatops 14 full grown nymphs of Capnia in rapid succession, which should represent a bulk about equal to that of the nymph that ate them. It ate a dozen quickly, the last two more slowly: it had been without food several weeks. Nymphs of the species described below as C. maculatus supposition, at Saranac Inn, captured and ate young brook trout as long as themselves, when placed in their cage. So eager were they, they would rise partly from the sand on approach of a trout. Like the nymphs of the Aeschninae, they seem to have a decided preference for big game, if one may judge by the strenuous efforts they put forth when something at the limit of their capacity for capturing approaches.

Our species belong to a single genus.

CORDULEGASTER Leach

Of the seven species occurring north of Mexico six are found in the eastern United States, and of these six, five are likely to be found in New York state when careful collecting is done for them. But two of these, C. erroneus (from Keene valley) and C. diastatops, are on record from the state; a third, C. maculatus is recorded below from Saranac Inn.

Imagos of the six species of the eastern United States may be separated by the following table:

a Eyes not contiguous; the proximal inferior tooth of the superior abdominal appendage of the male almost completely incased within the 10th segment (subgenus Zoraena)
b Abdomen with yellow lateral spots; stigma brown ..... diastatops
bb Abdomen with yellow half rings; stigma yellow ..... sayi
aa Eyes contiguous; proximal inferior tooth of superior appendage of male more or less completely exposed
b Two cubito-anal cross veins before the triangles; triangle open, or divided by a single cross vein; stigma moderate (subgenus Cordulegaster)
c Abdomen with yellow lateral spots ..... maculatus
cc Abdomen with yellow half rings ..... erroneus
bb Usually three cubito-anal cross veins before the triangle; triangle often divided by more than one cross vein; stigma very long (subgenus Taeniogaster)
d Abdomen with lateral yellow spots (southern) ..... fasciatus
dd Abdomen with a middorsal line of spots ..... obliquus

ARTIFICIAL KEY TO THE SAME SPECIES

a Abdomen with a middorsal line of spots ..... obliquus
aa Abdomen with yellow half rings on the segments
b Face yellow ..... sayi

bb Face blackish..... erroneous
aaa Abdomen with lateral spots
c Abdomen 65 mm or more in length (southern)..... fasciatus
cc Abdomen less than 60 mm in length
d Spots single on sides of abdominal segments..... diastatops
dd With large, separate, median and apical spots on sides of middle abdominal segments ..... maculatus

As to the nymphs, few of them are known. Cabot[1] has figured and described as C. sayi (supposition) nymphs, which, later, Hagen[2] has referred to C. diastatops (supposition). These nymphs were from Maine, Massachusetts, Maryland and Virginia. It is very doubtful whether C. sayi occurs so far north as Massachusetts: owing to confusion of species, published records of distribution of our species of Cordulegaster need sifting. I have bred C. diastatops at Ithaca, and my nymphs agree with Hagen's description, and thus confirm his supposition. In the above cited paper Dr Hagen also published brief descriptive notes on two other Cordulegaster nymphs which he referred by supposition to C. dorsalis (of the Pacific slope) and C. obliquus (the latter one, a single imperfect specimen from Texas). This is all that has been published concerning the nymphs of American species of this genus.

I describe below nymphs of C. diastatops (raised) and C. maculatus (supposition), and in order to avoid repetitions, I will give herewith a general statement of the characters of nymphs of the genus: they are all very much alike.

Nymphs of this genus agree in the following points: the body is stout, rough, hairy, cylindric, tapering beyond the middle of the abdomen to a pointed apex, the longitudinal axis upcurved at both ends, the tips of the eyes and the abdominal appendages being the highest points. The antennae are seven-jointed, slender. The eyes cap the angular anterolateral prominence of the head and extend a pair of sharp points internally on the vertex from their hind angles. Hind angles of the head rounded, the hind margin not obviously concave posteriorly. The labium is very large, extending posteriorly between the bases of the middle legs, its dilated, spoon-shaped anterior end covering the face up to the antennae, and meeting above a convex frontal prominence, whose margin is fringed with sensory hairs. The mentum is triangularly widened beyond the middle; its median lobe is produced in a median tooth which is bifid on the median line; its lateral lobes are broad, triangular, concave, and bear a row of short raptorial setae just within the external margin, a stouter, but not longer movable hook at the end of this row, and a series of coarse, irregular interlocking teeth on the distal margin.

1 Immature state of the Odonata. 1872. pt 1, p. 13, pl. 3, fig. 2.
2 Monograph of the earlier stages of the Odonata, Am. ent. soc. Trans. 1885. p. 290.

Prothorax with a transverse dorsal flattened area, which is fringed with stiff hairs; legs slender and not very long, adapted, not for running as stated by Hagen (*loc. cit.* p. 288), but for raking the sand aside; femora and tibiae with dorsal and ventral rows of long hairs, the ventral row on the tibiae graduating into spines at the tip, these becoming arranged in a double row on the ventral side of the tarsal segments; tarsi three-jointed; wings a little divergent on the two sides, when grown, reaching the fourth abdominal segment.

Abdomen, subcylindric, arcuately upcurved toward the tip; no dorsal hooks; lateral appendages less than one fourth as long as superior and inferiors; the transverse apical rings on the abdominal segments are somewhat remote from the apices of the segments and bear rows of very stiff hairs, which are incurved at the tip and serve to hold a layer of sand, dirt, etc. about the body.

The two species of nymphs described below may be easily separated as follows.

a Lateral margins of abdominal segments 8 and 9 sharp, ending posteriorly in stout triangular, conspicuous lateral spines..... diastatops (raised)

aa Lateral margins of abdominal segments 8 and 9 hardly acute, at their posterior ends a pair of minute, slender, cylindric, pointed spines, that are shorter than the hairs among which they are hidden..... maculatus (supposition)

Of the eggs of Cordulegaster I know nothing. Field observations are much needed on the matter of oviposition to observe whether they are dropped into the water, attached to supports, or inserted into plant tissues, and, if the latter, how the long, imperfect ovipositor of the female is used.

Cordulegaster maculatus Selys

1854 Cordulegaster maculatus Selys, Acad. Belg. (2) Bul. 21:105

1861 Cordulegaster maculatus Hagen, Synopsis Neur. N. Am. p. 115

1875 Cordulegaster maculatus Hagen, Bost. soc. nat. hist. Proc. 18:50 (bibliography and distribution)

1893 Cordulegaster maculatus Calvert, Am. ent. soc. Trans. 20:246 (description)

This species was not uncommon at Saranac Inn. It was to be seen during the greater part of the summer on sunshiny days coursing up and down Little Clear creek on the hatchery grounds: it was observed nowhere else. It has not been reported from New York state hitherto.

The nymphs referred to this species by supposition (none of them being reared) were common in the sandy bed of Little Clear creek, in the places over which the imagos were observed flying; but one species was seen; that is the reason for referring the nymphs to this species. A number of exuviae were found on the edges of the fish ponds within a few days after our arrival, but none appeared later, and, though nymphs apparently fully grown were repeatedly taken and a good many of them kept in our cages through the remainder of the season, none of them trans-

formed. I believe that the season for their transformation was past and that the period of adult life for this insect is a long one. The few specimens captured were all males.

Nymph. Measures in total length 41 mm; abdomen 30 mm; hind femur 6 mm; width of head 7 mm, of abdomen 8 mm.

Body very densely rough hairy; colors (entirely obscured except after molting) yellowish marked with brown spots; a pair of these at the base of the fore wings, a double submedian row along the dorsum of the abdomen, oval, with apices convergent in each pair: external to these, another row each side with apices divergent; external to these, a less conspicuous row each side, of spots lying nearer the bases of the segments; superior and inferior appendages yellow, black tipped, fringed densely on their internal margins with soft black hairs; laterals one fifth as long, not fringed.

Fig. 16 Labium of nymph of Cordulegaster maculatus Say, supposition

Mentum of labium bell-shaped in outline (fig. 16); median lobe very long and dilated on the cleft apex in a pair of flat ovoid lobes, with serrulated margins and each with an external apical denticle; lateral lobe with 10 or 11 very unequal sharp teeth on distal margin, the longest of the teeth, the movable hook and the setae of about equal length, the hook several times as thick as the setae; setae five; setae on mentum 10 or 11, six or seven longer ones in a longitudinal row at the sides, and four small ones extending from the proximal end of this row toward the median line.

Abdomen with segments about equal in length as far as the 10th, which is about one third shorter; appendages equal the ninth segment in length; in the female the long triangular lobes of the ovipositor extend to the apex of the ninth segment, against which they are closely applied; lateral spines, minute cylindric pointed rudiments, hidden among the hairs of the lateral margins, on the eighth and ninth segments.

Cordulegaster diastatops Selys

1854 Thecaphora diastatops Selys, Acad. Belg. (2) Bul. 21: 101

1886 Cordulegaster lateralis Scudder, Bost. soc. nat. hist. Proc. 10: 211

1872 Cordulegaster sayi (nymph) Cabot, Mus. compar. zool. Mem. v. 2, art. 5, p. 13, pl. 3, fig. 2

1885 Cordulegaster diastatops (nymph, supposition) Hagen, Am. ent. soc. Trans. 12:290 (description)

1878 Thecaphora diastatops Selys, Acad. Belg. Bul. p. 685 (descriptive notes and corrections)

1895 Cordulegaster diastatops Calvert, N. Y. ent. soc. Jour. 3:45 (listed from New York state)

This is a common species about the upland spring bogs near Ithaca and McLean N. Y. I have collected the nymphs by hundreds from the brownish vegetable debris of the puny streams trickling through such places.

The nymph differs from the preceding species in being a trifle smaller, and considerably less hairy; the lateral margins of segments 8 and 9 of abdomen are thin and sharp and bear sharp triangular spines; the labium is less widened just before the bases of the lateral lobes; the median lobe is less produced, more deeply notched in the middle, and the two lobes separated by this median notch are again cleft by a lesser notch.

Possibly these differences in median lobe of labium and in lateral margins of abdominal segments 8 and 9 may prove constant for the subgenera Zoraena and Cordulegaster.

LIBELLULIDAE

Skimmers

This family is a host, and includes many of the commonest of our species. Most of them are of well sustained flight, and are seen continually hovering over the surface of still water, or are met with on the uplands while foraging. The females do not insert their eggs into the tissues of plants, but drop them loosely into the water, or hang them in strings about plant stems at the surface of the water.

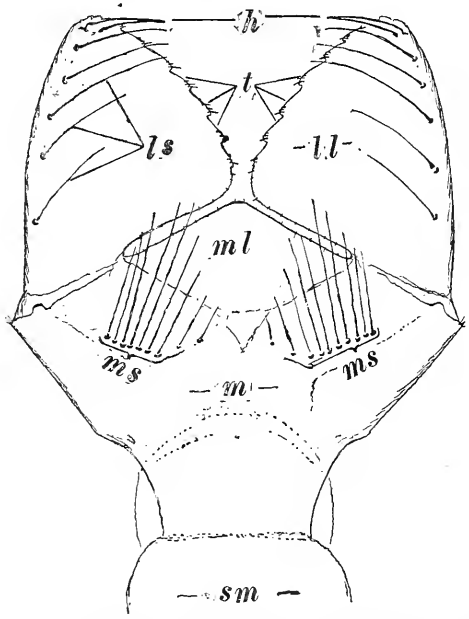

Fig. 17 Diagram of the Libellulid nymph labium (Perithemis domitia). *Sm* submentum; *m* mentum; *ms* mental setae; *ml* median lobe; *ll* lateral lobes; *ls* lateral setae; *t* teeth; *h* movable hook

The nymphs are sprawlers on the bottom, mainly in shallow water, or clamberers over fallen plant stems, and are protectively colored. They agree in the following characters: the labium (fig. 17) is masklike, spoon-shaped, with raptorial setae, and with its lateral lobe toothed on its distal margin; the antennae are seven-jointed, and setiform; the tarsi are three-jointed, with the third joint never as long as the two basal ones together; the wing cases are

long, reaching the sixth abdominal segment when the nymph is grown; lateral spines are present on abdominal segments 8 and 9, but the dorsal hooks are very variable, and often wanting.

Of the three subfamilies characterized below, the first one is here newly set apart; the other two are so closely allied that no single abso-

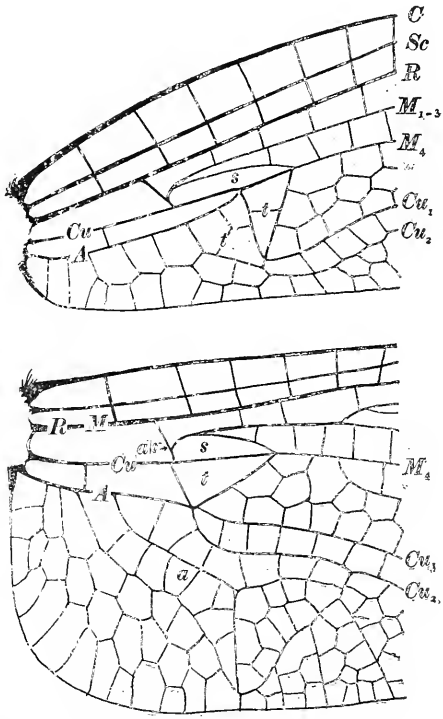

Fig. 18 Bases of wings of Leucorhinia glacialis Hagen. *C* costa; *Sc* subcosta; *R* radius; *M* media; *Cu* cubitus; *A* anal vein; *ar* arculus; *t* triangle; *t'* subtriangle; *s* supra triangle; *a* anal loop

lutely distinctive character has yet been found that will separate all the imagos. A combination of characters seems to be necessary for distinguishing both imagos and nymphs: a combination is therefore used in the following tables.

KEY TO SUBFAMILIES

Imagos

a The triangle of the hind wing placed considerably beyond the arculus; the anal loop well developed, and hardly longer than broad; with more than two cubito-anal cross veins ..... Macromiinae

aa The triangle of the hind wing (fig. 18) retracted to the level of the arculus, or even passing it a little sometimes; the anal loop, greatly elongated (except in Nannothemis) and becoming foot-shaped: one or two cubito-anal cross veins.

b Sectors of the arculus (veins M_{1-3} and M_4) distinctly separate at their departure from the arculus; anal loop elongate, but not distinctly foot-shaped, the toe part being little or not at all developed; the last antenodal cross vein extending from the costal to the radial veins (except in D. lintneri, in which it generally extends only from the costal to the subcostal); colors often metallic blue or green on thorax and abdomen ..... Cordulinae p. 484

bb The sectors of the arculus in close apposition or completely fused for a little way beyond the arculus; anal loop generally distinctly foot-shaped, with well developed "toe"; the last antenodal cross vein often discontinuous at the subcostal vein..... Libellulinae p. 506

Nymphs

a Head with a prominent pyramidal frontal horn; abdomen flat, and almost circular in outline as seen from above; legs long, giving a spiderlike aspect to these big nymphs; 10th abdominal segment well exposed, not telescoped in the apex of the ninth segment; teeth on the lateral lobes of the labium with deep incisions between them..... Macromiinae

aa Head without pyramidal frontal horn; abdomen less flattened, more elongate; teeth on the lateral lobes of the labium much wider than high.

b Lateral appendages of the abdomen more than half as long as the inferiors; hind femora longer than the head is wide; when the lateral spines are long (fig. 19*s*), then there is a full series of big, cultriform dorsal hooks on the abdomen ..... Cordulinae

bb Lateral abdominal appendages generally less than half the length of the inferiors; hind femora generally as long as the head is wide; often when the lateral spines of the abdomen are long the dorsal hooks are wanting or reduced ..... Libellulinae

Subfamily MACROMIINAE

A small group of large species, more distinct than any other group within the family. The imagos are bulky and not very graceful, hairy and not strikingly beautiful in their coloration, but their flight is strong and well sustained: they glide through the air with the fearless abandon of masters of a situation.

The nymphs are quite unique in the family in the possession of a flat abdomen, almost circular in outline, recalling that of Hagenius, though less flat and circular than that, and an erect pyramidal horn on the front of the head; in this last character, they are unique among all Odonata. They lie flat on the bottom where there is little mud, or oftener, on some nearly bare ledge in the border of a stream, with their thin legs radiately arranged, and the body almost completely covered with silt. Thus they await their prey and seize it when it approaches. They are all an undetermined number of years reaching maturity.

Our two genera may be separated as follows:

Imagos

a Dorsal surface of the head with the occiput larger than the vertex; subtriangle of the fore wings usually divided by a cross vein; four to six cross veins in the space above the bridge (*see* fig. 9)..... Didymops

aa Dorsal surface of the head with the occiput much smaller than the vertex; subtriangle of the fore wings generally open; two or three cross veins in the space above the bridge..... Macromia

Nymphs

a Head hardly as wide across the eyes as across the bulging hind angles; lateral spines not incurved, those of the ninth abdominal segment hardly surpassed by the tips of the appendages; dorsum of the 10th abdominal segment with no trace of a dorsal hook..... Didymops

aa Head widest across the eyes; spines of the ninth abdominal segment shorter, not nearly reaching the level of the apices of the appendages; dorsum of the 10th segment with a very rudimentary dorsal hook..... Macromia

DIDYMOPS

There is a single species.

Didymops transversa Say

1839 Libellula transversa Say, Acad. nat. sci. Phil. Jour. 8:19

1861 Didymops transversa Hagen, Synopsis Neur. N. Am. p. 135

1875 Macromia transversa Hagen, Bost. soc. nat. hist. Proc. 18: 57 (full bibliography, and distribution)

1890 Macromia transversa Cabot, Immature state Odon. pt 3, p. 14–16, pl. 1, fig. 3 (full bibliography, description of nymph and distribution)

1893 Didymops transversa Calvert, Am. ent. soc. Trans. 20:250 (description)

1899 Didymops transversa Kellicott, Odon. Ohio, p. 88 (description)

1900 Didymops transversa Williamson, Dragon flies Ind. p. 307 (description)

This is a common species in woodland streams and ponds, in water of a little depth, in shaded pools, etc., where there is little vegetation. It was not very common at Saranac Inn, but nymphs were taken in the borders of Little Clear pond and creek, and exuviae were found along the eastern shore of Lake Clear, hung up in the bushes, or attached to large rocks several yards from the water's edge. Imagos were observed only about the borders of the larger bodies of water. They could always be seen darting in and out of the edges of the woods on the fragrant shores of Little Green pond.

Nymph. (Pl. 18, fig. 8) Measures in total length, ♂ 27 mm, ♀ 29 mm; abdomen 19 mm; hind femur 11 mm; width of head 7 mm, of abdomen 13 mm. Body flat, thin edged, with legs wide apart at bases and sprawling. Color yellowish below, mottled brownish above, the

mottlings darker toward the middle line, and on the lateral ridges of the thorax; a darker band covering the top of the head, including the eyes, but not the frontal horn, which is yellowish, sprinkled on its upper side with brownish prickly granulations.

Head compact, bulging behind the eyes, which cap the elevated anterolateral angles; antenna with the basal segment twice as long as the second, about as long as the third; the succeeding segments gradually becoming a little shorter; hind angles of the head obtuse angled superiorly; rear of head a little concave; prothorax with a flat, angular fringed process each side, fitted snugly against the sides of the head; tarsi with the second and third joints of about equal length, the first joint about one third as long; femora and tibiae ringed obscurely with brown; wing cases reaching almost to the apex of the sixth abdominal segment.

Abdomen flat, with thin, flat lateral margins, and a median row of large, cultriform, dorsal hooks on segments 3-9, these same segments longer at the sides than on the median line; long, straight, lateral spines on segments 8 and 9, on 8 slightly divergent, on 9 parallel, as long as or longer than the body of the segment; 10th segment annular, inserted into an apical excavation of the ninth, one third as long as the length of the ninth on its middorsal line; appendages about as long as 9 above, subequal, or the laterals a very little shorter. Thorax broadly excavate below for the reception of the labium, with a pair of supporting humps beside it on the mesothorax and another one behind it on the metathorax.

Labium large; mentum broadly triangular, strongly contracted at its basal fourth, with a moderately prominent and declined median lobe, and about seven raptorial setae each side, the two inner ones quite small; lateral lobe ample, concave, with five raptorial setae and a hook that is stouter but little longer than the setae; distal margin with about six or seven crenate oval teeth, each bearing several graduated spinules.

MACROMIA

Two species are regional, but only one of them has as yet been taken within the state (M. illinoiensis); the other (M. taeniolata) is found from Pennsylvania southward as far as Florida. Neither has as yet been bred. Cabot[1] has described nymphs referred by supposition to each. Till these are reared it is hardly worth while to repeat descriptions in detail. It will suffice to give a general account of the characters of nymphs of this genus, and to state in tabular form the chief differences between the two species of nymphs believed to be the two species named.

The nymphs of the genus are short and flat, with widely sprawling legs. The shape of the prominent eyes, elevated on the laterosuperior angles of the head, and of the frontal horn, offer specific characters: the head is widest across the eyes, and slowly narrowed behind them, to the obtuse hind angles, each of which bears a tubercle on its upper aspect. The wings reach well over the sixth abdominal segment. There are strong cultriform, dorsal hooks on abdominal segments 2-9, and there is

1 Immature state of the Odonata. 1890. pt 3.

a low median ridge representing another on the 10th segment, often little evident. The lateral spines, which occupy the sides of the eighth and ninth segments, are generally stout and flattened, and do not reach the level of the tips of the appendages. The 10th abdominal segment is a little shorter than the ninth.

Imagos

a Length of abdomen generally less than 50 mm; expanse of wing less than 100 mm; thoracic dorsum usually without yellow stripes ..... illinoiensis

aa Length of abdomen about 60 mm; expanse of wing more than 110 mm; dorsum of the thorax with a pair of short, yellow stripes..... taeniolata

Nymphs

a Lateral spines of abdomen directed posteriorly, hardly incurved; pyramidal horn on the front of the head acute at apex...illinoiensis, supposition

aa Lateral abdominal spines strongly incurved at the tip; pyramidal horn on the front of the head obtuse, hairy..... taeniolata, supposition

Macromia illinoiensis Walsh

1862 Macromia illinoiensis Walsh, Acad. nat. sci. Phil. Proc. p. 397

1893 Macromia illinoiensis Calvert, Am. ent. soc. Trans. 20: 251 (description)

1897 Macromia illinoiensis Van Duzee, N. Y. ent. soc. Jour. 5: 89 (listed from Grand Island)

1899 Macromia illinoiensis Kellicott, Odon. Ohio, p. 87 (description)

1900 Macromia illinoiensis Williamson, Dragon flies Ind. p. 308 (description)

1890 Macromia illinoiensis (nymph supposition) Cabot, Immature state Odon. 3: 16, pl. 1, fig. 2 and pl. 2, fig. 1

A species which ranges from New Hampshire to Texas. Though taken but once as yet within the state, it probably dwells in the borders of a number of our larger bodies of water. I have not seen the imago at large. I have seen a few of the nymphs referred to this species, and may add a descriptive note covering some points unnoticed by Cabot.

A nymph 26 mm long has a length of abdomen of 16 mm; of hind femur of 11 mm; a width of head of 7.5 mm, of abdomen of 11 mm.

Head a little narrowed behind the very prominent eyes to the hind angles, above each of which is a little superior tubercle; labium greatly widened anteriorly, and concave, forming an immense mask; lateral setae six, with two little axial setae at the base of the lateral lobe within; mental setae five each side, close together in row, with several more minute, detached ones nearer the median line; teeth about five, large, oblique, each armed with about four or five spinules.

The few nymphs I have found were all obtained from clayey banks among wave-washed roots of trees, in places most difficult to use a net.

Macromia taeniolata Rambur

1842 Macromia taeniolata Rambur, Ins. Neur. p. 139
1861 Macromia taeniolata Hagen, Synopsis Neur. N. Am. p. 132
1874 Macromia taeniolata Hagen, Bost. soc. nat. hist. Proc. 16:359
1893 Macromia taeniolata Calvert, Am. ent. soc. Trans. 20:250 (description)
1899 Macromia taeniolata Kellicott, Odon. Ohio, p. 86 (description)
1900 Macromia taeniolata Williamson, Dragon flies Ind. p. 309 (description)
1890 Macromia taeniolata (nymph, supposition) Cabot, Immature state Odon. Pt 3, p. 9, pl. 2, fig. 4.

Distributed from Pennsylvania to Florida and Illinois.

KEY TO NORTH AMERICAN GENERA OF CORDULINAE (*s. str.*)

Imagos

a Veins M_4 and Cu_1 in the fore wing parallel or a little divergent apically, the number of rows of cells between them increasing toward the margin of the wing[1] ..... Neurocordulia

aa Veins M_4 and Cu_1 in the fore wing approximated toward the margin of the wing

b The second cubito-anal cross vein (and therefore, the subtriangle) normally present in the hind wing (absent occasionally in Helocordulia)

c Triangle of hind wing divided by a cross vein ..... Epicordulia

cc Triangle of hind wing without cross vein, open

d Anal loop symmetrically truncated at its distal end, with but three cells at the end; stigma very narrow and sharp-pointed at its ends Helocordulia

dd Anal loop unsymmetrically truncated at its distal end, with more than three cells at the end; stigma wider and less sharply pointed Somatochlora

bb The second cubito-anal cross vein absent in the hind wing

c Triangle of the fore wing traversed by a cross vein, with two complete rows of cells in the space beyond it

d Wings with black basal markings; inferior appendage of the male, not bifurcated ..... Tetragoneuria

1 One species, the little Cordulia lintneri of Hagen, may seem to belong in this section of the table, though of course, not in the genus Neurocordulia; it is also a synthetic type, lacking the special corduline features of venation, which I take to be 1) the approximation of veins M_4 and Cu_1, and 2) the general reduction of cross veins; it shows strong libelluline affinities in the conformation of the anal loop and in the possession of a half-antenodal cross vein just before the nodus. We may expect that its nymph when discovered will throw light on its true relationships. I leave it here in the genus Dorocordulia beside the two species with which it has hitherto been associated.

dd Wings clear; inferior abdominal appendage of the male deeply bifurcated, the forks again notched at tips; never with less than five antenodals in the hind wing, or with the triangle of that wing traversed by a cross vein ..... Cordulia

cc Triangles of the fore wings open ..... Dorocordulia

So well marked are these genera that they may generally be recognized at a glance by the following.

Single distinctive characters

Epicordulia alone has large brown spots at base, nodus and stigma of all wings.

Tetragoneuria alone has but four antenodals in the hind wing.

Helocordulia alone has the stigma very narrowly diamond-shaped, with the ends of it meeting the sides by an angle of 30°–35°.

Cordulia alone has the inferior abdominal appendage of the male deeply bifurcated.

Dorocordulia alone has the triangle of the fore wing free from cross veins.

Neurocordulia has been sufficiently distinguished above; Somatochlora possesses none of the characters of this list.

Nymphs

a Lateral setae four or five; mentum about as long as wide.. Epicordulia

aa Lateral setae seven; mentum of labium longer than wide

b Abdomen with large, laterally flattened, generally cultriform dorsal hooks

c Lateral spines of the ninth segment longer than half the length of that segment; dorsal hooks on segments 3–9, highest on 6, cultriform, and sharp ..... Tetragoneuria

cc Lateral spines of the ninth segment shorter than half of that segment; dorsal hooks less developed

d Dorsal hooks on segments 4–9 laterally flattened, but obtuse at apices, and not cultriform..... Somatochlora[1]

dd Dorsal hooks on segments 6–9, longest on 8 and cultriform Helocordulia

bb Abdomen with no dorsal hooks, or with these rudimentary, not flattened laterally or cultriform, but small obtuse or pointed prominences

c Hind angles of the head rounded; lateral spines of the ninth abdominal segment one fifth as long as that segment..... Cordulia

cc Hind angles of the head angulate superiorly; spines of the ninth abdominal segment one third as long as that segment ....Dorocordulia

1 There can be little doubt that the unknown nymphs of the numerous species of this genus will necessitate an amplification of the characters herein stated. S. elongata appears to be the only American species yet reared. Cabot described a nymph as that of Som. albicincta, supposition, but I am unable to say whether the supposition was correct: so far as one may judge from his figure, that one might as well have been Cordulia shurtleffi. The typical Somatochlora metallica of Europe has dorsal hooks on segments 3-9 of abdomen, with the posterior ones better developed than in S. elongata. It must be borne in mind by those who use this table that it is based only on the nymphs of the species herein described.

NEUROCORDULIA

No species of this genus has been taken within the limits of this state, but the following one is regional, being distributed from Massachusetts to Indiana. The nymph of the genus is unknown, unless the one described below be it. That nymph described and figured by Cabot and indicated as belonging possibly to this species, is Libellula pulchella.

Neurocordulia obsoleta Say

1839 Libellula obsoleta Say, Acad. nat. sci. Phil. Jour. 8: 28
1839 Libellula polysticta Burmeister, Handb. ent. 2: 856
1861 Didymops obsoleta Hagen, Synopsis Neur. N. Am. p. 136
1873 Epitheca obsoleta Hagen, Bost. soc. nat. hist. Proc. 15: 269
1863 Cordulia modesta Walsh, Ent. soc. Phil. Proc. 2: 254
1890 Epitheca obsoleta Hagen, Psyche, 5: 369, pl. 1, fig. 7-9 (critical notes, with figures of the accessory genitalia)
1893 Neurocordulia obsoleta Calvert, Am. ent. soc. Trans. 20: 252 (description)
1900 Neurocordulia obsoleta Williamson, Dragon flies Ind. p. 312

This species seems to be everywhere rare. I have not seen it at large. There are very few specimens in collections. It is very different in many particulars from all the other Cordulinae. It is very desirable that some one should rear it. The imago will be easily recognized by the characters given in the table. I describe below a nymph from Pennsylvania which probably belongs here.

Nymph. (Not grown) Measures in total length 18 mm; abdomen 8mm; hind femur 5 mm; width of head 5 mm, of abdomen 8 mm; length of body without antennae 17 mm.

A singularly flat-bodied, short-legged nymph with exceptionally contracted abdomen, smooth, blackish in color, with traces of paler bands on the femora and tibiae.

Head dorsally flattened, with a pair of low, submedian, vertical tubercles, and a shelf-like, scurfy pubescent frontal ridge, as long as the two basal segments of the antennae; antennae seven jointed; joint 1 cylindric, 2, globular, these of equal length; segments 3-7 slightly decreasing in length to the conic seventh segment. Hind angles of the head obtuse, but prominent posteriorly, overhanging the front of the prothorax; hind margin of the head excavate between the hind angles.

Labium short and broad, hardly extending posteriorly beyond the bases of the fore legs; mentum broadly triangular, contracted at its base, concave within, its sharp superolateral margins spinous at both ends; median lobe moderately prominent, with a few minute spinules on the front border of it, declined; mental setae eight or nine, the three or four innermost ones quite small each side; lateral lobes triangular, concave within, its distal border cut in about seven semi-elliptic teeth, each armed at its tip with two or three spinules, lateral setae five; movable hook a little longer and stronger than the setae, gently arcuate.

There is a distinct occipital ridge on the rear of the head below the level of the vertex, closely applied to a corresponding ridge on the front

margin of the prothorax. The dorsal shield of the prothorax farther bounded on the posterior side by a transverse ridge, which curves forward at its ends to terminate in a pair of prominent lateral processes; there is also an obtuse supra-coxal process each side which extends forward close beside the head halfway from the hind angles of the head to the eyes.

Body depressed; legs smooth, wide apart, the three pairs successively more remote from each other at base, the middle and hind femora each with a superior ridge, the fore and middle tibiae each with a ridge, starting at its base exteriorly (dorsally) and at once curving to extend down its anterior face; tarsi three-jointed, the third joint about as long as the two basal together, the claw short and stout, about as long as the basal joint.

Abdomen flat, suborbicular, granulate, with a row of oval smooth scars midway between the median line and the lateral margin each side on segments 4–8; wing cases reaching but to the middle of the fourth abdominal segment (the nymph is apparently not grown); there is a row of conspicuous dorsal hooks starting from between the wing cases and ending on segment 9; strongly flattened laterally, not hooked at all, but erect, and rounded on tips, highest on the sixth segment; ventral sutures wide apart, slightly convergent posteriorly, disappearing on the ninth segment; basal abdominal segments extremely contracted, segment 1 telescoped by the metathorax, visible only in the middle of the ventral side; genitalia (♂) visible at the midventral apex of segment 2; lateral spines on 8 and 9, long and sharp, divergent on 8, parallel on 9 and as long as the segment, greatly surpassing the appendages; segment 9 excavate above between the lateral spines, to inclose the annular 10th segment and the appendages, one half as long on the middorsal as on the midventral line; inferior appendages about as long as segment 9 is on the dorsal side, the superior and the laterals successively shorter, the latter a little longer than half the inferiors; segment 10 about half the dorsal length of the ninth segment; inferior apical and lateral margins of the ninth segment fringed with long hairs.

A single nymph[1], sent me by Dr Calvert, from the collection of the Academy of natural sciences of Philadelphia, bearing the label, "H. C. Borden, Pa. Oct. 26, '95".

The flat abdomen with erect blunt dorsal hooks and smooth lateral scars, and the elongate third tarsal segment recall Hagenius, while the broad mask-shaped labium, the vertical tubercles and the frontal ridge recall Epicordulia. The transverse occipital ridge, the curving carina on the fore and middle tibiae, and the extreme abbreviation of the basal abdominal segments are characters which I do not recall having observed in any other nymphs whatever.

1 Since the above was written I have received exuviae from Dr Calvert, taken at White lake in the Catskills, and from E. B. Williamson, taken at Nashville Tenn., of this same species. The length of the nymyh when grown is 21 mm. I now feel quite certain that these belong to Neurocordulia.

EPICORDULIA

We have a single species.

Epicordulia princeps Hagen

Water prince (Pl. 22, fig. 1)

1861 Epitheca princeps Hagen, Synopsis Neur. N. Am. p. 134

1875 Cordulia princeps Hagen, Bost. soc. nat. hist. Proc. 18:61 (bibliography)

1893 Epicordulia princeps Calvert, Am. ent. soc. Trans. 20:251 (description)

1899 Epicordulia princeps Kellicott, Odon. Ohio, p. 88 (description)

1900 Epicordulia princeps Williamson, Dragon flies Ind. p. 310 (description)

1890 Epitheca princeps Cabot, Immature state Odon. pt 3, p. 25, no. 12, pl. 3, fig. 3 and no. 13, pl. 4, fig. 3 (*juv.* nymph)

1889 "Libellulina nymphs nos. 10 and 12." Garman, Ill. state lab. nat. hist. Bul. 3, 3:179

This species is distinguishable from all the following even in flight by its large size and its brown wing blotches at nodus and stigma. It is a widely distributed species, locally common where there are ponds or sluggish streams with muddy, reed-grown banks. Imagos appear on the wing in May and continue flying through midsummer. They seem absolutely tireless in flight; very rarely indeed is one seen resting. The males at least prefer the surface of still water, over which they will sweep back and forth in zigzag lines and broad curves hour after hour.

The nymphs sprawl on the bottom amid fallen reeds, or clamber over submerged logs. In winter I have found numbers of them crowded in the crevices of a submerged stump.

Transformation takes place very early in the morning. The nymphs will crawl several meters from the edge of the water if necessary in order to find a proper support. They are stiff creatures with legs set wide apart, and, not being good climbers of reeds, generally seek some broader supporting surface, such as the side of a stump, or a cluster of grass blades. The eggs are dropped by the female while flying alone, dips being made far out in open water, and widely distributed.

Nymph. (Pl. 21, fig. 2) Measures in total length 27 mm; abdomen 17 mm; hind femur 8 mm; width of head 7.5 mm, of abdomen 8 to 12 mm, there being very great variation in this last measurement.

Since this nymph has been figured and described by Cabot, it will suffice here to give a brief statement of the more distinguishing characteristics. Head a little narrowed behind the small eyes, which cover the anterolateral angles; there is a pair of low conic tubercles on the top of the head, these larger in younger nymphs, and sometimes even cultriform. The statement that the young nymphs of this species do not differ

from the grown nymph in this respect is sometimes (but very rarely) true. Labium with four (less often five) lateral setae, and four larger mental setae each side, with one or two lesser ones near the median line. Thorax with broad sterna.

Abdomen depressed, triquetral; dorsal hooks large, cultriform, in a very regular series, on segments 2–9; lateral spines on segments 8 and 9, those of the ninth segment surpassing the level of the tips of the appendages; superior appendage very nearly as long as the inferiors, laterals a little more than half as long as the inferiors.

There are two indistinct and interrupted bands of brownish markings, extending from the hind angles of the head to the bases of the spines on the ninth abdominal segment, and there are darker rings on tibiae and femora, discoverable specially after molting.

This species was seen but a few times at Saranac Inn, and no specimens were taken either as nymphs or imagos. It is not uncommon in other places in the state, and will probably be found quite generally distributed when proper search is made for it.

TETRAGONEURIA

This North American genus is one of the most important, most generally distributed, and most common in the subfamily. The imagos are somewhat scarce in collections, but they are by no means so in nature. Because of their superb aerial powers they are not often taken in flight. They depart widely from the regular haunts of the less active species while foraging, and thus often escape the specialist who is collecting for dragon flies in particular. The roving habits of the imagos account sufficiently for the wide distribution of most of our species.

About an Illinois pond in which Epicordulia princeps and Tetragoneuria cynosura were the only Cordulinae present, I have watched day after day the little Tetragoneuria chasing the big Epicordulia about in air, much as a kingbird chases and harasses a crow, surpassing by its swiftness and by its ability to make quick turns in air.

Nymphs of this genus may be found in almost any pond; they are often found in enormous numbers. By far the easiest way to get imagos is to capture well grown nymphs and rear them.

Nymphs of this genus agree so closely that I give here a general account of them, which, for specific descriptions will only need to be supplemented by the specific characters stated in the following table; the differences therein stated are the only differences I know between the species.

The nymphs are trim and smooth, with depressed abdomen and long lateral spines. The general color is greenish or yellowish, with a

longitudinal band of brown each side of the thorax, rings on femora and tibiae, and obscure, interrupted, longitudinal rows of spots on the abdomen. Head compact, with eyes very prominent laterally, and the front somewhat swollen between the bases of the antennae; labium with its mentum distinctly longer than wide, the median lobe prominent, declined, minutely spinulose on its front border, with two stouter spinules at the sides of the apical angle; lateral setae seven; mental setae six to nine; movable hook slightly incurved, and sharply pointed; teeth crenate, spinulose.

Abdomen roof-shaped; segments 3-9 about equal in length, the 10th a minute annular segment almost included within the apex of the ninth; dorsal hooks on segments 2-9, spine-like anteriorly where covered by the wings, distinctly cultriform posteriorly; lateral spines on segments 8 and 9 long and broad at base.

Four species are tabulated below: one of these, T. spinosa, has not been hitherto recorded from this state. These four were all common at Saranac Inn, excepting the typical T. cynosura. So common were they, in fact, that I stumbled on two desirable bits of information concerning the genus that I should probably have missed had they not been very common. The first of these relates to the proportionate abundance of the sexes. Males mainly are collected by the ordinary methods; and for half a century or more students of the group have been remarking on the striking preponderance of males in this and other genera. I collected on Blueberry island in Little Clear pond in about 10 minutes 111 cast skins of T. spinigera and T. semiaquea, intermixed, taking them as they came, without any selection whatever. These were separated as to species and sexes (the males being easily recognized by the indications of the secondary genitalia on the ventral side of the second abdominal segment) and counted, with the following results: T. spinigera, ♂s 22, ♀s 24; T. semiaquea, ♂s 25, ♀s 40, in both cases a slight excess of females. I once counted a large number of skins of T. cynosura, and E. princeps taken from Purington lake at Galesburg Ill. I have not the figures resulting from the count, but I remember distinctly that there was in each case a slight excess of females. The females are more shy and seclusive, and therefore less often taken. My breedings have never revealed any material excess in numbers of either sex for any species; and these are certainly more reliable than chance captures in air.

An acquaintance with the eggs of Tetragoneuria was likewise almost forced on me. These are laid in strings, attached together in masses (as shown in fig. 19) and hung on partly submerged twigs at the surface of the water. These were very common objects about the shores of Little Clear pond. I did not see any of them laid. That they belong

to Tetragoneuria is, therefore, an inference: it is sufficiently justified by the following considerations.

1) Tetragoneuria was the only libellulid sufficiently common at the pond to have produced the enormous number of eggs observed there. I think one might easily have filled a barrel with the clusters that could have been picked up at the surface of this pond: the cluster shown in the figure (which was smaller than the average) contained about 110,000 eggs (counted in part, and estimated), and with its enveloping gelatin

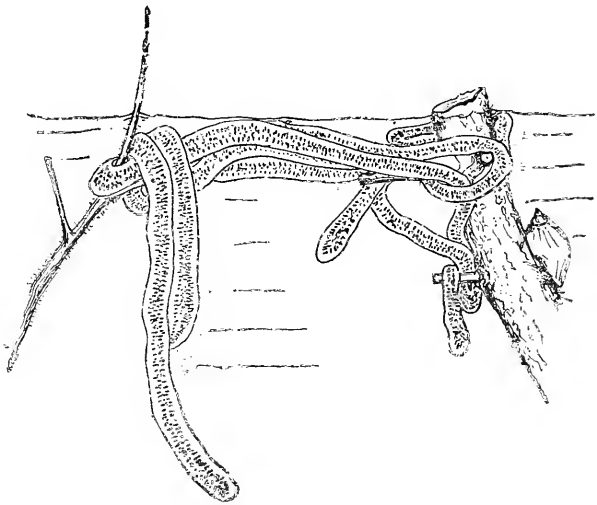

Fig. 19 Eggs of Tetragoneuria hung on submerged twigs near surface of the water

would have about filled a half pint measure. These clusters are doubtless the work of a number of females; the separate strings are often indicated by the ends left hanging free. These are undoubtedly libellulid eggs: none of our larger Libellulinae lay their eggs in strings; nor do the smaller Cordulinae, but the European genus Epitheca, not distantly related to Tetragoneuria, does so.

No other Cordulinae were common at this pond. I did not get more than a single nymph or imago of any other save Cordulia shurtleffi, and of that less than a dozen in all, there. But Tetragoneurias were abundant above all that I have ever seen elsewhere. They were scattered all about the margin excepting, perhaps, the bare shores of part of the north side, and were apparently rather uniformly distributed. I counted the number of cast skins of Tetragoneuria, without regard to species, clinging to the thin grass tussocks and fallen twigs along the water's edge for a distance of several rods at two places: at the north

side of the bay in Blueberry island, and on the outside of the cape which projects across the outlet, and found the number averaged 30 to a meter in distance along the shore line. When one reflects that there were miles of favorable shore line in this pond, the number of imagos suggested by a little calculation will account for a considerable quantity of eggs.

2) I hatched thousands of these eggs. While the nymphs of Libellulidae, when new-hatched, look much alike, these showed corduline characters quite as much like Tetragoneuria as any other.

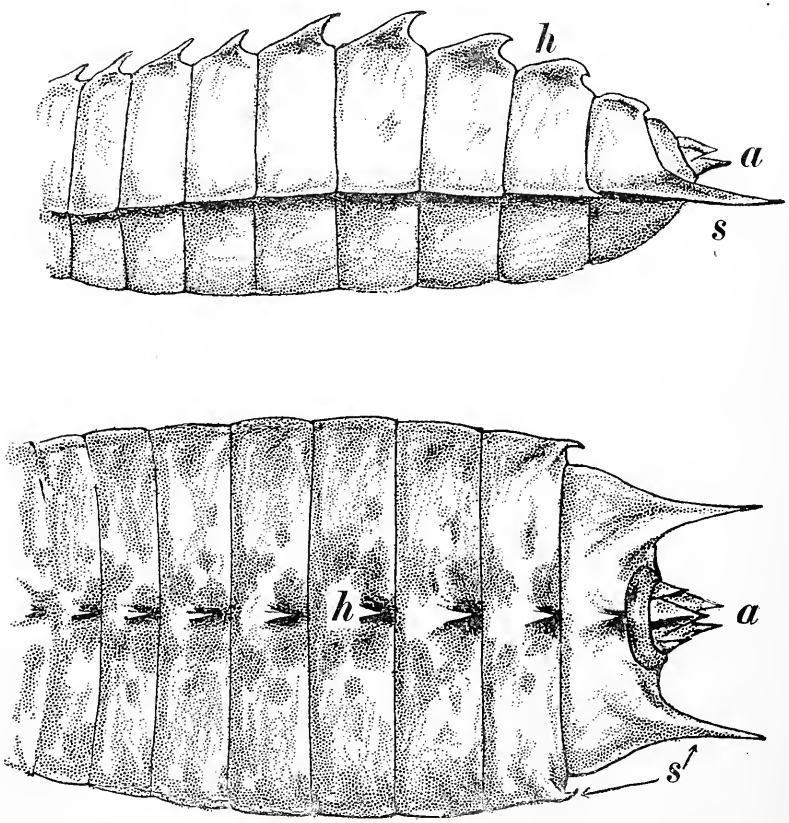

Fig. 20 Lateral and dorsal views of the abdomen of the nymph of Tetragoneuria cynosura Say. *a* Appendages; *h* dorsal hooks; *s* lateral spines

Of the three species found at Saranac Inn I bred two species of the nymphs, and found other nymph skins which I have below referred by supposition to the other species (T. spinosa). The recognition characters for imagos and nymphs of the four species of the state are given below in tabular form.

SPECIES OF TETRAGONEURIA

Imagos

a Frons with a black T spot above; triangle of hind wings generally without a cross vein ..... spinigera

aa Frons without a T-spot above; triangle of hind wings generally traversed by a cross vein

b Superior appendage of the male not declined at tip, and without superior ante-apical spine. Hind wings generally with four antenodal cross veins.

c Hind wing with isolated basal streaks which hardly surpass the level of the first antenodal cross vein ..... cynosura

cc Hind wings with broader, and more confluent markings, reaching the level of the third or fourth antenodal cross vein ..... semiaquea

bb The superior appendage of the male strongly declined at the tip beyond a superior ante-apical spine; hind wings generally with five antenodal cross veins, some of the antenodals surrounded by fuscous spots... spinosa

Nymphs

a Spines of the ninth abdominal segment strongly divergent, their tips distinctly wider apart than their bases on the outer sides..... spinigera

aa Lateral spines of the ninth segment, very slightly or not at all divergent

b Spines of the ninth abdominal segment longer than the segment

c Spines of the ninth segment hardly longer than is the segment on its dorsal side (fig. 20) ..... cynosura

cc Spines of the ninth segment one third to one half longer than is the segment on its ventral side ..... semiaquea

bb Spines of the ninth segment distinctly shorter than that segment, and slightly incurved at tips..... spinosa, supposition

Tetragoneuria spinigera Selys

1871 Tetragoneuria spinigera Selys, Acad. Belg. (2) Bul. 31:269

1897 Tetragoneuria spinigera Van Duzee, N. Y. ent. soc. Jour. 5:90 (listed from Buffalo)

1897 Tetragoneuria spinigera Calvert, N. Y. ent. soc. Jour. 5:95 (listed from Buffalo)

1900 Tetragoneuria spinigera Williamson, Dragon flies Ind. p. 311 (description)

To the above record by Van Duzee of this species from Buffalo (repeated by Calvert in his list), I have to add two localities. It was exceedingly abundant at Saranac Inn during the month of June, flying about the grounds of the hatchery in company with the other two species occurring there—flying, also, about every other little clearing in the forest, foraging. It was very common toward the mouth of Buttermilk creek near Ithaca in June 1897.

Tetragoneuria cynosura Say

Dog-tail

1839 Libellula cynosura Say, Acad. nat. sci. Phil. Jour. 8:30
1839 Epophthalmia lateralis Burmeister, Handb. ent. 2:847
1873 Cordulia cynosura Hagen, Bost. soc. nat. hist. Proc. 15:271
1861 Cordulia lateralis Hagen, Synopsis Neur. N. Am. p. 139 (description)
1893 Tetragoneuria cynosura Calvert, Am. ent. soc. Trans. 20:252 (description)
1895–97 Tetragoneuria cynosura Calvert, N. Y. ent. soc. Jour. 3:46 and 5:93 (listed from Ithaca, Lake George, Black Rock)
Tetragoneuria cynosura Kellicott, Odon. Ohio, p. 89 (description)
1900 Tetragoneuria cynosura Williamson, Dragon flies Ind. p. 311
1890 Epitheca cynosura (nymph) Cabot, Immature state Odon. pt 3, p. 28

This species, which has hitherto been recorded from but few localities within the state, is likely to be found in most large ponds in central and western New York. I have but one additional locality to record. I have received specimens from Prof. Herrick collected at Canandaigua.

I have not united with this species semiaquea Burmeister, notwithstanding that I think them one species showing racial variations, because there is no difficulty, so far as I have observed, in separating the imagos on the basis of the color distinction long in use, and because my bred nymphs do not agree very closely, and I have not had time for the study of a long series of these nymphs. I would call attention, however, to a fact indicating either that they will probably be found to intergrade, or that some one has made an error or mixed his specimens. Cabot described a longer and a shorter type of nymph of the straight-spined form: the one with the longer spines was bred and was T. cynosura; the one with the shorter spines was referred to T. semiaquea on supposition. From the shorter spined of my two with straight spines I bred abundantly in Illinois the typical T. cynosura. I have observed, however, that there is considerable variation in the length of these spines: there seems to be much less of it in their direction. While it seems likely that T. semiaquea will eventually rank as a race of T. cynosura, pending farther study, I have listed them separately here.

Tetragoneuria semiaquea Burmeister

1839 Libellula semiaquea Burmeister, Handb. ent. 2:858
1842 Cordulia complanata Rambur, Ins. Neur. p. 145
1874 Cordulia semiaquea Hagen, Bost. soc. nat. hist. Proc. 16:360
1861 Tetragoneuria semiaquea Hagen, Synopsis Neur. N. Am. p. 140 (description)
1893 Tetragoneuria semiaquea Calvert, Am. ent. soc. Trans. 20:252
1895–97 Tetragoneuria semiaquea Calvert, N. Y. ent. soc. Jour. 3:46 and 5:93 (listed from Ithaca, Baldwinsville, Black Rock)

Tetragoneuria spinosa Hagen

1878 Tetragoneuria spinosa Hagen, Acad. Belg. (2) Bul. 45 : 188

This species was less abundant at Saranac Inn than the others of the genus mentioned as occurring there; but I captured at random a number of specimens of both sexes. The female shown in pl. 22, fig. 2, exhibits a singular type of coloration for this genus. The wings were of a rich flavescent brown, with spots of black on a number of the antenodal cross veins. This specimen I captured among the wild raspberry bushes near the house of the station agent at dusk, June 27.

Owing to the striking difference between the male appendages in this and the other species of the genus, there is probably no need here of a new description, notwithstanding that the original one in French seems as yet to be the only one, and it is not generally accessible in this country.

HELOCORDULIA gen. nov.

The two species constituting this genus, C. uhleri Selys and C. selysi Hagen, have been included hitherto in the genus Neurocordulia. There is hardly another genus within the corduline series as here restricted, with which these have less affinity. A tabular statement of the differences between Helocordulia and Neurocordulia (as here restricted) with respect to wing venation will show the great discrepances for a single organ—the only one I have critically studied.

CHARACTER	NEUROCORDULIA	HELOCORDULIA
Veins M_4 and Cu_1	divergent apically with the cell rows between increasing from 2 to 5	convergent apically with but two cell rows between
Stigma	broad and slightly oblique	narrow and very oblique at its ends
Antenodals of hind wing	five	six
Triangle of fore wing	of three cells	of two cells
Triangle of hind wing	of two cells	open; no cross vein
Apex of anal loop	with a long posterior angle, and at least five cells resting against the distal margin	squarely truncate or nearly so, with but three cells on the distal end

Helocordulia is most nearly allied to Tetragoneuria. There are however a few venational characters which readily distinguish the two genera.

CHARACTER	TETRAGONEURIA	HELOCORDULIA
2d cubito-anal cross vein	absent	nearly always present
Under the stigma	a single cross vein followed by a wide space	two cross veins and more normal spaces
Antenodal cross veins of the hind wing	four or five	six

The anal loop is slightly wider and more oblique at the apex in Tetragoneuria. T. spinosa has the antenodal cross veins spotted with fuscous much as in Helocordulia.

The nymph of Helocordulia is peculiar among the known corduline nymphs in having dorsal hooks on segments 6–9 only, with some

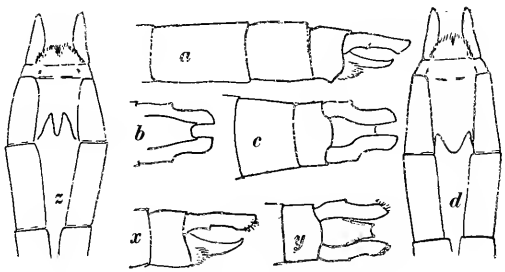

Fig. 21 Helocordulia, genitalia: *x*, *y* (♂) and *z* (♀) of H. uhleri Selys: *a*, *b* (ventral view), *c* (♂) and *d* (♀) of H. selysi Hag.

of these distinctly cultriform, and in the extreme abbreviation of the ninth abdominal segment on the dorsal side, so that its dorsal length is less than half its ventral.

The two species of the genus may be separated as imagos by reference to the figures herewith presented. The nymph is known for but one of these, H. uhleri, the only one apparently belonging to the New York fauna.

Helocordulia uhleri Selys

1871 Cordulia uhleri Selys, Acad. Belg. (2) Bul. 21:274

1890 Neurocordulia uhleri Beutenmüller, Dragon flies vs mosquitos, p. 164 (listed from New York)

1895 Neurocordulia uhleri Calvert, N. Y. ent. soc. Jour. 3:46 (listed from New York)

This species was not uncommon in Little Clear creek on the hatchery grounds. Imagos were seen flying a few times about the banks of Little Clear pond close in shore and low above the water. They are so swift and agile, and their wings are so transparent that the eye follows them with difficulty. They are not very difficult to capture however, if one will place himself beside a regular "beat", and bring his net up behind the dragon fly with a quick stroke when it is passing. I found the imagos showing no disposition to avoid me even after escaping a stroke of the net several times. Twice I saw three males chasing one another up and down Little Clear creek, and had little difficulty in capturing them.

The nymph was not reared. Some of them, apparently about grown, were kept through the season without result. Apparently, the season for their transformation was over before any were found. There can be

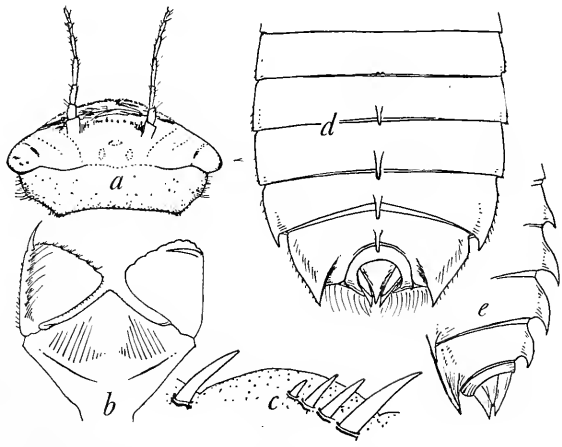

Fig. 22 Parts of nymph of Helocordulia uhleri Selys. *a* dorsal view of the head; *b* labium, from within, details in part omitted on the right; *c* a single tooth from the front border of the lateral lobe of the labium; *d* dorsal view of the abdomen; *e* lateral view of apex of abdomen, to show better the dorsal hooks

scarcely a doubt, however, as to the correctness of the reference of them to this species, when one considers that the only other corduline observed here like this one in size was D. libera, which I reared.

The nymphs live in the borders of the creek, mainly in the shallow places, filled with red-rotten vegetable debris — the haunts of the giant

crane fly, Tipula abdominalis, and the phantom fly, Bittacomorpha clavipes, larvae. But little collecting was done in such net-clogging situations, and hence, but a few of the nymphs were obtained. A single cast skin was found on a stump in the edge of a boggy place in Little Clear outlet, about eight inches above the surface of the water.

Nymph. Measures in total length 20 mm, abdomen 11 mm; hind emur 6 mm; width of head 5 mm, of abdomen 7 mm.

Color brownish, due to copious incrustation in all my specimens, with no visible color pattern.

Head compact, slightly broader than long; eyes only moderately prominent, with parabolic curve on the anterior side; antennae with segments about equal, the last, perhaps, a little shorter and pointed; labium reaching posteriorly between the bases of the fore legs and hardly beyond them; mentum triangular, channeled; the median lobe rather prominent, declined, fringed sparsely with short spinules along its fore margin; mental setae about 10 or 11, the fifth or sixth (counting from the side) longest; lateral setae seven or six, when seven the basal one smaller than the others; movable hook hardly longer than the setae, but much stouter; lateral lobe with about seven low crenate teeth on its distal border, each armed with two or three graduated spinules.

Prothorax with a prominent lateral process at each side of the dorsum and a similar anteriorly directed process above the fore coxa; legs slender and sparsely hairy; tarsi with the first joint about half as long as the second, which about equals the third in length.

Abdomen broadly oval, with dorsal hooks on segments 6-9, on 6 rudimentary, a mere low pointed tubercle, on 7-9 cultriform, largest on 8. Lateral spines on segments 8 and 9, a little larger on 9, short, triangular, sharp, those of 9 about one third as long as that segment, and about reaching the level of the tips of the appendages. Segment 10 is minute, annular, inserted into the apex of the ninth segment, which is less than half as long on its middorsal as on its midventral line; superior and inferior appendages about as long as segment 9 above, laterals one third shorter.

SOMATOCHLORA

This genus is by far the largest in our corduline fauna. I have set apart three species hitherto placed in it, and, with these aside, it still comprises about half of the subfamily. The species seem to be common only in high altitudes in the northern part of the United States, and in British America. In all my collecting I have observed but one species in flight. This species was S. elongata, of which a few specimens were seen flying about the borders of Bone pond on Aug. 14. I obtained one nymph only of the species. That one was from Little Clear pond. From it I bred a fine male imago July 5. This seems to be the only specimen bred for all of our species; and so diverse are the imagos among themselves that the nymphs may hardly be expected to conform closely to the characters of this one in details. I give herewith figures of the

genitalia of both sexes of the five species listed below. These are the characters most used in characterizing them, and are the ones most reliable in determining specimens. These figures show the appendages to be unusually well marked with individuality. The nymphs of this genus offer an open field for study by collectors in boreal latitudes. Four species, tenebrosa, walshii, linearis and elongata, are recorded from the state. To this I have nothing to add but a new locality for the last named, and a partial life history of it. One other species occurs farther southward, and is almost certain to be taken in this state eventually, and is therefore included among the species listed below.

Somatochlora elongata Scudder

Plate 21, fig. 15

1866 Cordulia elongata Scudder, Bost. soc. nat. hist. Proc. 10:218

1895 Somatochlora elongata Calvert, N. Y. ent. soc. Jour. 3:46 (listed from Ithaca)

The few imagos I saw of this species were flying with great swiftness about the borders of Bone pond. The single nymph I found was taken

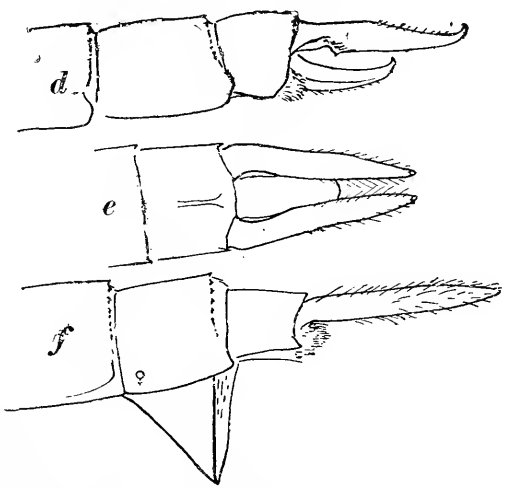

Fig. 23 Somatochlora elongata Scudd., end of abdomen; *d* and *e* of male; *f* of female

from Little Clear pond, as stated above, and transformed July 5. A cast nymph skin was found later in the season on the north side of the outlet of Little Clear, sprawling on a bed of moss but a few inches above the water line.

Nymph. Measures in total length 26 mm; abdomen 15 mm; hind femur 7.5 mm; width of head 7 mm, of abdomen 9 mm.

Body of the form of Cordulia, or slightly broader, sparsely hairy on appendages and margins; head with hind angles well rounded, the eyes moderately prominent; labium as in Cordulia, but with 13 or 14 mental setae, of which the fifth or sixth (counting from the side) is longest, the four or five internal ones being quite minute; lateral setae seven; teeth low, crenate, each armed with four or five graduated spinules.

Abdomen oblong, with not very sharp lateral margins, most narrowed posteriorly on the ninth segment; lateral spines on the eighth and ninth segments, those of the ninth segment about one fourth as long as the body of the segment; dorsal hooks on segments 4 to 9, small and erect points on segments 4 and 5, larger and laterally flattened and nearly equal on segments 6–9, but without sharp decurved apices; ninth segment about half as long on the middorsal as on the mid-ventral line, inclosing the annular tenth segment; lateral appendages hardly shorter than the equal lateral and superior appendages.

Somatochlora filosa Hagen

1861 Cordulia filosa Hagen, Synopsis Neur. N. Am. p. 136

1893 Somatochlora filosa Calvert, Am. ent. soc. Trans. 20:253 (description)

1900 Somatochlora filosa Williamson, Dragon flies Ind. p. 313

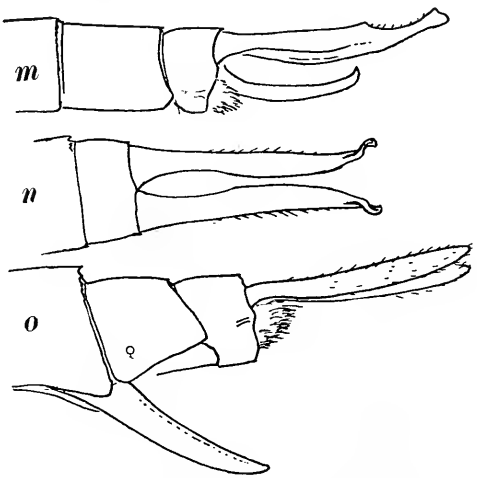

Fig. 24 Somatochlora filosa Hag., end of abdomen; *m* and *n* of male; *o* of female

This species is recorded from New Jersey and southward, and is very likely to be met with in New York state eventually.

Nymph unknown.

Somatochlora linearis Hagen

1861 Cordulia linearis Hagen, Synopsis Neur. N. Am. p. 137
1893 Somatochlora linearis Calvert, Am. ent. soc. Trans. 20:253 (description)
1897 Somatochlora linearis Calvert, N. Y. ent. soc. Jour. 5:95 (listed from Oswego co., and Grand Island N. Y.)
1900 Somatochlora lateralis Williamson, Dragon flies Ind. p. 313 (description)

A species I have not met with. Its nymph is unknown.

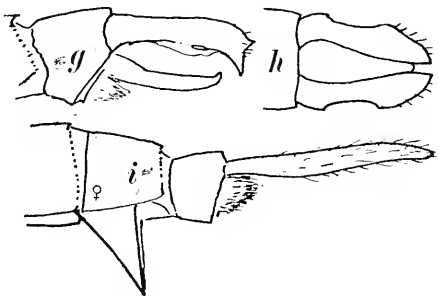

Fig. 25 Somatochlora linearis Hag. end of abdomen; *g* and *h* of male; *i* of female

Somatochlora walshii Scudder

1866 Cordulia walshii Scudder, Bost. soc. nat. hist. Proc. 10:217
1897 Somatochlora walshii Calvert, N. Y. ent. soc. Jour. 5:95 (listed from Keene Valley)

Nymph unknown.

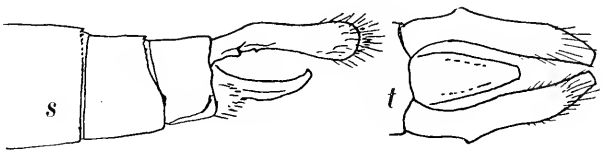

Fig. 26 Somatochlora walshii Scudd., *s* dorsal, and *t* lateral views of appendage of the male

Somatochlora tenebrosa Say

1839 Libellula tenebrosa Say, Acad. nat. sci. Phil. Jour. 8:19
1861 Cordulia tenebrosa Hagen, Synopsis Neur. N. Am. p. 137
1895-97 Somatochlora tenebrosa Calvert, N. Y. ent. soc. Jour. 3:46 and 5:93 (listed from New York, Clarence and Oswego co.)
1900 Somatochlora tenebrosa Williamson, Dragon flies Ind. p. 314 (description)

Nymph unknown.

For location of descriptions of other species of the genus, some of which are likely to be taken in this state when careful collecting is done, consult the three bibliographic lists mentioned on p. 431.

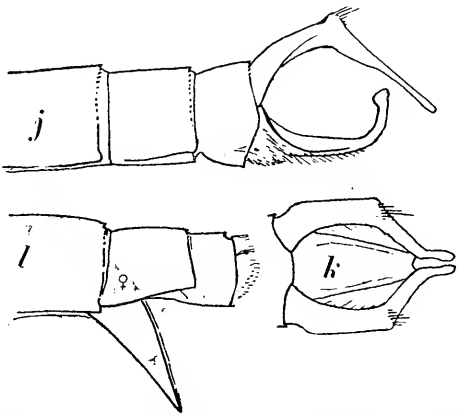

Fig. 27 Somatochlora tenebrosa Say, end of abdomen, *j* and *k* of male; *l* of the female (appendages omitted)

CORDULIA

There is a single species belonging to our fauna.

Cordulia shurtleffi Scudder

1866 Cordulia shurtleffi Scudder, Bost. soc. nat. hist. Proc. 10: 217
1871 Cordulia shurtleffi Hagen, Bost. soc. nat. hist. Proc. 15: 377

This species seems not to have been recorded hitherto from New York state. It was common at Saranac Inn. A few imagos were observed flying about the hatchery grounds, and along the creek, but their favorite resort for foraging and sport was the edge of a boggy pond hidden in the deep woods—such a pond, for instance, as the one a quarter of a mile south of the station, or the one north of the outlet of Little Clear pond back of the cabins. I spent a few of the pleasantest hours of the summer collecting on the springy border of the pond first named, immersed to the knees in the sinking sphagnum moss, a floating islet of sphagnum, decked with beautiful orchids, cut off by a narrow strait of clear green water at my feet. The Cordulias would fly along this strait between the islet and the moss on which I stood, and within reach of my net. There were generally a dozen or more about at a time, and one could be expected to traverse the strait every few minutes—often enough to keep a collector interested. So fleet are they, however, and so artful at dodging a net that generally a good many minutes elapsed between captures. Their flight is as free and graceful as their coloration is beautiful. Rarely was one seen to alight, but oc-

casionally one would sweep out into the forest and disappear among the hemlocks.

The nymphs obtained were gathered from a shaded trashy place in the edge of Little Clear pond and from Bone pond. They lie sprawling amid the trash after the manner of the better known Libellulas.

I did not rear these nymphs, the season of their transformation being over, apparently, before I obtained any of them. I kept a few in a cage through the greater part of the season: nevertheless, there is not the slightest doubt as to their identity. They agree very closely with the nymphs of the European C. a e n e a Linn., with specimens of which I have compared them. Male nymphs show in the stretched skin of the superior appendage the forked tip of the inferior appendage of the imago. The nymphs, like the imagos, were in numbers second only to the Tetragoneurias among the Saranac Cordulinae.

Nymph. Total length 21 mm; abdomen 12 mm; hind femur 6.5 mm; width of head 6 mm, of abdomen 7 mm.

Body elongate, sparsely fringed with coarse hairs on the appendages, edge of frons, rear of head, and lateral margins of abdomen; color greenish brown marked with blackish brown as follows: a tranverse band across the head including the eyes (almost divided by the median yellow ocellus when the nymph is grown) an urceolate median band on the prothorax not attaining its front margin, and divided by a fine yellow median line; a broad oblique lateral yellow band extending from above the base of the fore leg to the middle of the hind wing; below the last, a narrower parallel stripe above the base of the hind leg; a pair of submedian rows of blotches on the abdomen extending posteriorly from beneath the tips of the hind wings; and rings on femora and tibiae.

Head with the eyes laterally prominent and well rounded, hind angles obtuse and the hind margin slightly concave; no vertical tubercles; frontal ridge low obtuse; labium reaching posteriorly between the bases of the second pair of legs, triangular elongate, channeled above; median lobe prominent, declined; mental setae about 14, regularly graduated in size, the fourth (counting from the side) longest; lateral setae seven; movable hook hardly longer than the setae, nearly straight; teeth about nine, low, crenate, increasing in breadth inferiorly, each with several spinules.

Abdomen oblong, a little widened to the seventh segment, most narrowed apically on the ninth segment; 10th segment annular, half as wide as the ninth, and one fourth to one third as long as the ninth is on its middorsal line; ninth segment one half as long on the middorsal line as on the midventral; appendages almost equal, the superior and the laterals successively a very little shorter than the inferiors, which are about as long as segment 9 is on its dorsal side; lateral spines on segments 8 and 9 very short (about one fifth the length of the body of the segments which bear them), but pyramidal.

The first cast nymph skin was obtained June 16. The imagos were flying commonly throughout the month of July.

DOROCORDULIA gen. nov.

Cordulia libera Selys, type

The three species here separated from Somatochlora and placed in this new genus differ from Somatochlora by a number of important venational and other characters, among which are the following:

1 The triangle of the fore wing is open: it is traversed by a cross vein in Somatochlora.

2 There are never more than two complete rows of cells beyond the triangle in the fore wings: there are more than two in Somatochlora.

3 The second cubito-anal cross vein (and, therefore, an internal triangle or subtriangle) is wanting in the hind wing; it is present in Somatochlora.

4 There is a long space beyond the single cross vein under the stigma: in Somatochlora the spaces are more nearly equal, and there are often two cross veins under the stigma.

The Cordulia lintneri of Hagen may not belong here: in fact it may belong in the subfamily Libellulinae. I leave it here beside the species with which it has been associated pending farther study, and awaiting the discovery of its nymph. It will be found not to agree with characters 2 and 4 of the above statement.

This genus is more closely allied to Cordulia than to Somatochlora, but it differs from Cordulia by characters 1 and 2 as stated above, as well as by the lack of the deep bifurcation of the inferior appendage of the male which is characteristic of Cordulia. The nymph also, I found much more easy to distinguish from that of Somatochlora elongata than from that of Cordulia shurtleffi. The nymph is known for the single species D. libera.

Our imagos are readily separable into species by the following key:

a Abdomen with segments 7 to 10 spatulately dilated.....libera
aa Abdomen gradually and very moderately widened at apex
b The articulations of the abdominal segments yellow.....lepida
bb The articulations of the abdominal segments not yellow.....lintneri

Dorocordulia libera Selys

1871 Cordulia libera Selys, Acad. Belg. (2) Bul. 21:262
1895 Somatochlora libera Calvert, N. Y. ent. soc. Jour. 3:46 (listed from the Catskill mountains)

This dainty and beautiful corduline species was not uncommon at Saranac Inn. But few specimens were taken, because no special effort was made to get them. The imagos obtained were taken when flying with Cordulia shurtleffi about the borders of the bog ponds mentioned under the account of that species. They are less swift of

flight than that species, but they dash along shore on shining, transparent wings, dancing in and out of the little coves in the edge of the sphagnum fringe, and once in a while are seen resting on the tall summit of some pitcher plant flower.

The one nymph I obtained was taken from the edge of Little Clear pond at the outlet, and was reared, transforming July 7. From that cast skin the following description of the nymph was drawn up. The

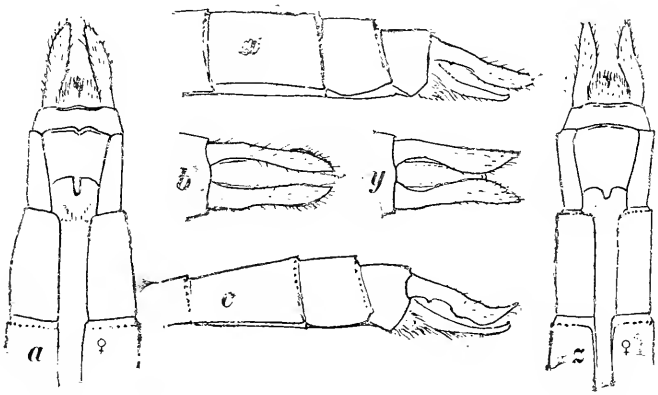

Fig. 28 Dorocordulia, end of abdomen. *a*, *b* and *c* of D. libera Sel.; *x*, *y* and *z* D. lepida Hag.

specimen is in the New York state collection at Albany. The study of this specimen, which was preserved and labeled by myself with such promptness and care as to preclude error or confusion of species among my specimens, reveals an error in Cabot's work on the corduline nymphs. The one he described as Som. libera, raised, can not have been of that species. I have not seen his specimen, but both his description and his figure disagree utterly with my specimen. They agree quite well with the nymph of Helocordulia uhleri, and I think they may have belonged to that species or to H. selysi.

Nymph. Total length 21 mm; abdomen 11 mm; hind femur 6 mm; width of head 5.5 mm, of abdomen 7 mm.

Very similar to the nymph of C. shurtleffi, but smaller, and with the black band across the head broader between the eyes, the eyes themselves more prominent laterally, and the hind angles of the head more angulate; labium similar; lateral setae seven; mental setae 12–13, each side, the fifth (counting from the side) longest, the others regularly grading up to it; abdomen similar, but the very rudimentary dorsal hooks a little more prominent on the middle segments (perhaps a little less obscured by tufted hairs about them); lateral spines longer on segments 8 and 9, about a third the length of their respective segments; inferior appendages longer than the superior, which in turn is longer than the laterals.

Dorocordulia lepida Selys

1871 Cordulia lepida Selys, Acad. Belg. (2) Bul. 31: 264
1872–75 Cordulia lepida Hagen, Bost. soc. nat. hist. Proc. 15: 270 and 18: 60
1895 Somatochlora lepida Calvert, N. Y. ent. soc. Jour. 3: 46 (listed from Albany)

This species was originally described from specimens sent from Albany; it seems not to have been taken in the state since that time. Its nymph is unknown.

Dorocordulia lintneri Hagen

1854 ——— ——— Emmons, Agric. N. Y. v. 5, pl. 15, fig. 1 (colored fig.: no name or description)
1878 Cordulia lintneri Hagen, Acad. Belg. (2) Bul. 45: 187
1890 Cordulia lintneri Hagen, Psyche, 5: 272, pl. 1, fig. 10-17 (a full account)
1895 Somatochlora lintneri, Calvert, N. Y. ent. soc. Jour. 3: 46 (listed from Center, Albany co.)

But few specimens are known of this very interesting species, which has a distribution from New York to Saskatchewan. Its nymph is unknown.

Subfamily LIBELLULINAE

This extensive group includes the commonest and best known of all our Odonata. The imagos are familiar figures above every pond and ditch, and by every roadside. The nymphs are less well known, notwithstanding their relative abundance, than in some of the smaller groups. Our tables which follow are the first to be given for American forms, and the descriptions also are entirely new, with the exception of the nymphs of Pantala and Tramea, which alone have been described by Cabot. The following keys will serve for the separation of both nymphs and imagos.

KEY TO GENERA

Imagos

a Triangle of the fore wings four-sided; anal loop poorly developed, not foot-shaped ..... Nannothemis p. 509

aa Triangle of the fore wing fully differentiated, three-sided; anal loop well developed and foot-shaped

b Triangle of the fore wing with its front and inner sides meeting by an angle of about 100°; the subtriangle without cross veins; the vein which bisects the anal loop straight ..... Perithemis p. 511

bb Triangle of the fore wing with its front and inner sides meeting by an angle of about 90°; subtriangle divided into three or more cells; bisector of the anal loop sinuous

c Triangle of the fore wing not placed distinctly beyond the level of the apex of the triangle in the hind wing; pterostigma with its ends parallel or not distinctly divergent

d The sectors of the arculus (veins M_{1-3} and M_4) in the fore wing more or less completely fused for a short distance beyond the arculus; the triangle of the fore wing not greatly produced posteriorly, and (except in Celithemis) normally containing but a single cross vein, and followed by two or three rows of cells

e Vein Cu_1 of the hind wing departing from the triangle at the hind angle

f Sectors of the arculus (veins M_{1-3} and M_4) contiguous, but incompletely fused for a distance beyond the arculus; wings generally conspicuously spotted with yellow or reddish brown
Celithemis p. 513

ff Sectors of the arculus in the hind wing distinctly fused for a distance beyond the arculus

g Stigma short and thick, about twice as long as wide; anal loop with a big heel, there being generally four cells between the bisector and the heel point; face pure white
Leucorhinia p. 516

gg Stigma more than three times as long as wide; anal loop generally with but two cells between the bisector and the heel point
Sympetrum p. 519

ee Vein Cu_1 of the hind wing migrated a little way up the outer side of the triangle, separating itself at a distance from the hind angle

f With a single cross vein under the stigma, and a long vacant space before that cross vein ..... Pachydiplax p. 526

ff With two cross veins under the stigma and the adjacent spaces more normal

g With a single row of cells between veins M_2 and R_s
Mesothemis p. 527

gg With two rows of cells for a distance between veins M_2 and R_s
Micrathyria p. 528

dd Sectors of the arculus in the fore wing contiguous, but not completely fused beyond the point of their departure from the arculus; radial sector distinctly undulate (except in Ladona); triangle of the fore wing very much elongated posteriorly and narrow and generally traversed by two or more parallel cross veins, and followed by three to seven rows of cells

e Vein M_{1a} arising under the proximal fourth of the stigma; fore wings with the subtriangle consisting of three cells, and the triangle followed by three rows of cells..... Ladona p. 528

ee Vein M_{1a} arising under the middle of the stigma; fore wings with the subtriangle consisting of four to 11 cells, and the triangle usually followed by four to six rows of cells

f Male with no ventral hooks on the first abdominal segment; female with the hind tibia a little longer than the hind femur; the sexes alike in wing pattern ..... Libellula p. 530

ff Male with a pair of ventral hooks on the first abdominal segment; female with the hind femur and tibia of equal length; wings dissimilarly colored in the two sexes ..... Plathemis p. 536

cc Triangle of the fore wing placed beyond the level of the apex of the triangle of the hind wing; stigma with its inner end perpendicular, its outer end very oblique to the bordering veins; wings broad at base and pointed at apex

d Radial sector regularly curved; hind wings with a broad, basal colored band..... Tramea p. 537

dd Radial sector distinctly undulate; hind wings not covered at base by a broad colored band..... Pantala p. 539

Nymphs

a Unknown..... Nannothemis[1] and Micrathyria

aa With large, cultriform dorsal hooks on abdominal segments 3-9; eyes small and situated on the midlateral margin of the head and directed laterally Perithemis

aaa With no dorsal hook on the ninth abdominal segment; eyes overspreading more or less the anterolateral margins of the head

b Basal segment of the hind tarsus more than half as long as the second segment; lateral appendages of the abdomen not more than half as long as the inferiors (except in Libellula quadrimaculata); superior abdominal appendage regularly tapering to a point

c Abdominal appendages strongly decurved; lateral spines wanting or extremely rudimentary..... Mesothemis

cc Abdominal appendages straight or very slightly declined; lateral spines evident on abdominal segments 8 and 9

d With no dorsal hooks at all; abdomen smooth, depressed; head twice as wide as long, with eyes very prominent laterally.. Pachydiplax

dd Dorsal hooks present, at least on the middle abdominal segments

e Abdomen ovate in outline, rather abruptly narrowed to the posterior end; hind margin of the eyes behind the middle of the head

f Lateral spines long and straight; abdomen not narrowed posteriorly before the eighth segment..... Celithemis

ff Lateral spines shorter and more or less incurvate; the abdomen more or less narrowed before the eighth segment

g Dorsal hooks as long as the segments which bear them Leucorhinia

gg Dorsal hooks shorter than the segments which bear them Sympetrum

ee Abdomen lanceolate in outline, slowly narrowed to the pointed posterior end; eyes capping the prominent anterolateral angles of the head, their hind margin generally before the middle of the top of the head; body generally hairy

1 Discovered since this key was prepared, and described below under the account of the genus.

f The 10th abdominal segment with subcarinate lateral margins; appendages very long; lateral setae 0-3 ..... Ladona

ff The 10th abdominal segment shorter, cylindric; appendages shorter; lateral setae 5-10

g Head a little narrowed behind the eyes; front border of the median lobe of the labium entire ..... Libellula

gg Head not narrowed behind the eyes to the hind angles; front border of the median labial lobe crenulate ..... Plathemis

bb Basal segment of the hind tarsus half as long as the second segment; lateral appendages of the abdomen at least three fourths as long as the inferiors; lateral setae 10 or more; superior appendage of the abdomen suddenly contracted at its basal third, the dorsal two thirds forming a long slender point

c Movable hook of labium long and slender, setiform; teeth much broader than high; spines of the eighth segment one half longer than the ninth segment; superior abdominal appendage shorter than the inferiors Tramea

cc Movable hook of the labium short, hardly longer than the teeth; teeth higher than broad; spines of the eighth segment as long as the ninth segment; superior appendage equaling the inferiors ..... Pantala

NANNOTHEMIS

There is a single species occurring within the state.

Nannothemis bella Uhler

1857 Nannophya bella Uhler, Acad. nat. sci. Phil. Proc. p. 87
1861 Nannophya bella Hagen, Synopsis Neur. N. Am. p. 186
1867 Nannophya bella Packard, Am. nat. 1:311, pl. 9, fig. 6
1893 Nannothemis bella Calvert, Am. ent. soc. Trans. 20:260 (description)
1895 Nannothemis bella Calvert, N. Y. ent. soc. Jour. 3:48 (listed from Westchester co. and New York)
1900 Nannothemis bella Williamson, Dragon flies Ind. p. 327

This is apparently a somewhat rare species. I have not seen it alive. It is known to be distributed from Quebec and Indiana to Florida. Since the foregoing key was prepared its nymph has been discovered by Mr R. Weith near Elkhart Ind. and he has published some notes on the life history of the species and I have described the nymph (Can. ent. 1901. 33:252–255). Mr Weith's notes are abstracted below, and my own description and figure are appended.

This species occurs in very restricted areas (50 yards in length by 25 yards in width from margin of the lake) in two places near Elkhart Ind. Unlike most other Odonata, the imagos do not fly higher than a few feet above the ground, preferring to alight on marsh grasses and bask in the sunshine, where numerous small Diptera suitable for food

hover over the little stagnant pools. Nymphs were first found in small holes in the almost dry marsh land, too small to allow the use of a net and containing but a few inches of water. A larger number was obtained later from debris deposited in the marsh during high water and still submerged a few inches. Removed from the water the nymph clings closely to the debris of exactly its own color, and does not stir even after letting this dry; so it is very hard to see and a difficult subject for collection.

Fig. 29 Nannothemis bella Uhl. Nymph, labial lobe of nymph, and eggs

The females oviposit in the shallow places where the nymphs live, in temporary water of one to two inches depth, and very warm. The female dips the tip of her abdomen to the surface after the manner of all Libellulines, but only about three or four times; then rests; then repeats. The eggs are creamy white turning dark in a short time, and with scanty gelatinous envelop. (From the account by Mr Weith)

Nymph. (fig. 29) Fully grown, measures in total length of body 10 mm; abdomen 5.5 mm; hind femur 3.5 mm; width of head 3.5 mm, of abdomen 4 mm.

Color almost uniform tawny yellowish brown, paler below and on the sutures, more or less completely obscured by adherent vegetable debris. Body moderately hairy on lateral margins, specially hairy toward the end of the abdomen.

Head compact, one third wider than long, scurfy hairy above excepting a pair of bare spots near the hind margin, with prominent hemispheric, eyes covering the anterolateral angles, narrower behind the eyes with parallel sides, rounded hind angles, and almost straight hind margin.

Antennae shorter than the head is long, seven-jointed, with scattering hairs along the distal joints. Labium extending posteriorly between the bases of the fore legs; median lobe broadly triangular, half as long as wide, rounded on tip, with two spinules close together just before the tip, and several others each side along the front border farther apart; raptorial setae on the mentum, 10 each side, the fourth or fifth (counting from the side) longest, the three innermost ones quite small; lateral labial lobes ample, with six raptorial setae, and a spinule at the base; hook straightish to the slender slightly curved tip, hardly longer than the setae, but much stouter; teeth almost obsolete, bispinulose.

Prothorax with prominent spiracles; legs hairy, specially the tibiae externally; tarsal claws not strongly incurved; second tarsal joint one half longer than the first, and the third one half longer than the second; wings reaching well on the sixth abdominal segment.

Abdomen somewhat depressed, oblong, widest on the sixth segment, the ninth segment as wide as the second; narrowed with extraordinary abruptness on the 10th segment, which is almost included within the apex of the ninth. No dorsal hooks at all; in their places are tufts of a few long hairs, and whitish spots in the ante-apical membrane of the segments. Lateral spines on segments 8 and 9, hooklike, starting outward at base, and incurved at tip, on eight one half the length of the segment, on nine, a little longer than on eight. Hairs on the apical carinae well developed, specially so on segment nine, which they completely incircle, constituting a long fringe which completely overhangs the 10th segment and the appendages. Appendages about as long as the ninth segment is on its slightly shorter dorsal side; lateral appendages a third shorter.

Since the discovery and description of the nymyh of Tachopteryx thoreyi Selys by Messrs Graf and Williamson, last year, this species has remained the most important discovery to be made. It is our only representative of that singular group of Libelluline genera which Karsch called the Nannophyae.[1] Mr Weith's zeal and industry have brought this nymph to light, and there now remains of all the genera of Odonata of the northern United States and Canada but two in which no nymph are known, and they are Gomphaeschna and Micrathyria.

PERITHEMIS

There is a single species occurring within the state.

[1] Ent. Nachr. 15 : 245–63.

Perithemis domitia Drury

Plate 24, fig. 3 and 4

Amber wing

I use the above scientific name in this place without having entered into the question of synonomy—a question for the determination of which I have no adequate material. Domitia is the name that has been used hitherto in most American descriptive papers. Dr Hagen regarded tenera and tenuicincta Say, chlora Rambur, metella Selys, and iris Hagen, as synonyms of domitia. Forms like those occurring in New York state were described by Say (1839) under two names, tenuicincta (♂) and tenera (♀). Should these be ranked as a species distinct from domitia the latter name, having precedence of position in Say's list, would be the name for the species. Hagen's *Synopsis of the Odonata of America*[1] and Kirby's *Catalogue of the Neuroptera Odonata*[2], represent the extreme views.

1773 Libellula domitia Drury, Illus. exotic ent. v. 1, pl. 47, fig. 4
1861 Perithemis domitia Hagen, Synopsis Neur. N. Am. p. 135
1893 Perithemis domitia Calvert, Am. ent. soc. Trans. 20:264 (description)
1895 Perithemis domitia Calvert, N. Y. ent. soc. Jour. 3:48 (listed from Westchester co.)
1898 Perithemis domitia Needham, Outdoor studies, p. 59, fig. 58 (♂) and 59 (♀)
1899 Perithemis domitia Kellicott, Odon. Ohio, p. 112 (description)
1900 Perithemis domitia Williamson, Dragon flies Ind. p. 317 (description)

This is a pretty, little brown species, with amber tinted wings. It is apparently not common in New York state, having been taken as yet only in the vicinity of New York city. I studied the species in Galesburg Ill., in 1895, and there worked out its life history.

It appears on the wing about the end of May, and flies through June. Its flight is rather weak, and a bit clumsy and slow. When over water it habitually avoids the altitude of the larger and stronger species, keeping down nearer the surface. It is very sensitive to cloudiness and moisture, being seldom seen in flight except when the sun is shining.

The female is sometimes held by the male while ovipositing, but I have seen her oftener unattended, dropping her eggs on bits of floating dead pond scum by many successive dips made at very nearly the same spot. When a female was taken in hand and "dipped" to the surface of water in a tumbler, 10 to 20 eggs were liberated by her at each descent.

1 Bost. soc. nat. hist. Proc. 1875. 18:82–83.
2 1890, p. 10.

The egg (pl. 19, fig. 8) is oblong oval, at first white, turning brownish gray after a few hours; its surface is closely beset with minute tuberculate granulations. The gelatinous envelop is scanty.

The nymphs clamber about over trashy submerged vegetation; they climb well, but swim very poorly. They are cleaner and less sprawling than the Libellulas. The nymph goes no farther from the edge of the water to transform than is necessary to find a suitable place—generally but a few inches.

Nymph. Total length 15 mm; abdomen 9 mm; hind femur 5.5 mm; width of head 4.5 mm, of abdomen 6 mm.

Head wider than long, slightly concave behind, widest across the rounded eyes, which are at the middle of its length; labium (fig. 8A) short, not extending posteriorly beyond the bases of the first pair of legs; lateral setae five; mental setae about nine or 10, the two innermost ones minute and out of line with the others, the fifth (counting from the side) longest; teeth crenate, well marked, each armed with several spinules; hook short, little curved, differing much from the setae behind it in its greater thickness and less length.

Femora twice ringed with black; wing cases extending over the sixth abdominal segment.

Abdomen (fig. 8C) broad, depressed, triquetral, in outline oblong oval; lateral spines on segments 8 and 9, short; dorsal hooks on segments 3–9; these form a regularly descending curve, and, viewed laterally, look like a segment of a circular saw; superior and inferior appendages equal; the laterals half as long.

CELITHEMIS

Two species of this genus, C. eponina and C. elisa, are known from this state, and a third, C. ornata, may be looked for toward the coast. These are three of the most beautiful among all our smaller species. Their colors are shades of black, red, yellow and brown; and the wings in all have a distinct color pattern.

The nymphs are known for the two species recorded from the state. They agree in having smooth bodies with depressed abdomen and long lateral spines. The head is wider than long, widest across the very prominent eyes, which at their sides are almost angulate, they project so sharply; the labium is very large, and has numerous very long and slender raptorial setae, and a pair of very long thin movable hooks; the teeth are almost obsolete, but the spinules which arm them remain. The abdomen is scarcely narrowed posteriorly before the ninth segment, so that the side margins seem to be continued posteriorly in the long spines of that segment. The superior appendage is one fourth, and the lateral appendages are one half shorter than the inferiors. Imagos and the two known species of nymphs may be separated by the following key.

KEY TO SPECIES OF CELITHEMIS

Imagos

a Wings spotted with brown beyond the nodus
b Expanse of wings at least 65 mm; a band of brown on the wings at the nodus reaching almost across the wings ..... eponina
bb Expanse of wings not over 60 mm; a small rounded spot of brown just beyond the nodus ..... elisa
aa Wings with no brown markings except at base ..... ornata

Nymphs

a Unknown ..... ornata
aa Dorsal hooks well developed on abdominal segments 4 to 7, longest on segment 6 and sharp; lateral spines of the ninth segment reaching level of the apices of the inferior appendages; lateral setae eight or nine ..... eponina
aaa Dorsal hooks weakly developed on segments 5 to 7, short, but pointed; lateral spines of the ninth segment attaining only the level of the tip of the superior appendage; lateral setae seven ..... elisa

Celithemis eponina Drury

Plate 24, fig. 2

1773 Libellula eponina Drury, Illus. exotic ins. v. 2, pl. 47, fig. 2
1861 Celithemis eponina Hagen, Synopsis Neur. N. Am. p. 147
1875 Celithemis eponina Hagen, Bost. soc. nat. hist. Proc. 18:66–67
1893 Celithemis eponina Calvert, Am. ent. soc. Trans. 20:261 (description)
1895–97 Celithemis eponina N. Y. ent. soc. Jour. 3:48 and 5:94 (listed from Westchester co. New York, Lake Bluff, Wayne co.)
1898 Celithemis eponina Needham, Outdoor studies, p. 60, fig. 60, (habits)
1899 Celithemis eponina Kellicott, Odon. Ohio, p. 103
1900 Celithemis eponina Williamson, Dragon flies Ind. p. 318

This beautiful skimmer is abroad about the latter end of June and the first weeks of July in our latitude. It frequents the borders of ponds and neighboring grassy slopes, and sometimes when foraging, it is carried far from water by the winds. Its flight is not the swiftest or the most continuous, and there is a flutter to it suggestive of the flight of a butterfly. So far as I have observed, the female in ovipositing is held by the male, and both are apt to be seen on windy days when other species are in shelter, dipping to the surfaces of foaming waves, far out from shore. The eggs are better distributed than in most related species, and, possibly for this reason, they seem to be somewhat fewer, and of larger size. Each egg is rotund oblong, whitish at first, soon turning yellowish.

Nymph. Total length 21 mm; abdomen 12.5 mm; hind femur 6 mm; width of head 6 mm, of abdomen 7 mm.

To the foregoing generic characterization of the nymphs of Celithemis and to the statement of the characters made for this species in the table, it need only be added here that in this nymph there is a blackish band between the eyes, and the femora are ringed with the same color; the abdomen is widest across the sixth segment, beyond which the sides seem scarcely narrowed to the tips of the lateral spines of the ninth segment; the lateral margins of segments 8 and 9 are conspicuously spinulose serrate.

The nymphs clamber about on submerged objects, and climb up stumps, etc., at the bank to transform, going but a little way, usually not farther than a foot.

Celithemis elisa Hagen

1861 Diplax elisa Hagen, Synopsis Neur. N. Am. p. 182
1867 Diplax elisa Packard, Am. nat. 1:311, pl. 9, fig. 5
1862 Celithemis elisa Walsh, Acad. nat. sci. Phil. Proc. p. 400
1875 Celithemis elisa Hagen, Bost. soc. nat. hist. Proc. 18:67
1893 Celithemis elisa Calvert, Am. ent. soc. Trans. 20:261 (description)
1895 Celithemis elisa Walsh, N. Y. ent. soc. Jour. 3:48 (listed from Long Island, New York and Ithaca)
1899 Celithemis elisa Kellicott, Odon. Ohio, p. 104 (description)
1900 Celithemis elisa Williamson, Dragon flies Ind. p. 318 (description)

This species has about the same seasonal range as the preceding. E. B. Williamson has written (*loc. cit.* p. 319-20) very interestingly of the habits of the imago, as follows.

This species may often be found resting on the inflorescence of some of the rushes, preferably the bulrush, Scirpus lacustris, growing in the shallow waters of our lakes. So perched on a swinging rush, they have a wide view of what is going on about them and at the same time are inconspicuous, harmonizing well with the dingy brown of the over ripe flowers to which they cling. From this vantage ground they make sudden dashes at passing Diptera and smaller dragon flies, often returning to the identical sedge time and again. Each is the proprietor of a particular locality. When one encroaches on the hunting territory of another, he is quickly hustled away by the rightful and irate owner . . . The females are more retired, and are usually found among the sedges back from the water's edge.

Nymph. Measures in total length 14.5 mm; abdomen 8 mm; hind femur 4 mm; width of head 4 mm, of abdomen 5 mm. These measurements are taken from a rather small nymph skin, from New England—a bred specimen, and the only specimen in my possession. I should expect the typical elisa nymphs from localities farther west would be of somewhat larger size.

? Celithemis ornata Rambur

1842 Libellula ornata Rambur, Ins. Neur. p. 96
1861 Diplax ornata Hagen, Synopsis Neur. N. Am. p. 182
1861 Diplax amanda Hagen, Synopsis Neur. N. Am. p. 183
1893 Celithemis ornata Calvert, Am. ent. soc. Trans. 20: 261 (description)

Maine to Florida along the coast; not as yet recorded from this state. Nymph unknown.

LEUCORHINIA

A single species, the common L. intacta, has been recorded hitherto from this state. A second species is now added, L. glacialis, which was common at Saranac Inn. I have bred, and describe below the nymphs of both these species, as well as the female imago of the latter species which has not hitherto been known.

Imagos of this genus flit about the vegetation of marshy shores, or go foraging along weedy roadsides near by. Their flight is not long sustained, consisting mainly of short sweeps from one resting place to another. The nymphs clamber among the submerged stems of aquatic plants. They are smooth, clean, and generally show a definite and well marked color pattern, of brown on a greenish ground, harmonizing well with the environment of mixed green and dead stems. They agree in having the eyes laterally prominent, but a little less so than in Celithemis, lacking the tendency toward the lateral angulation seen in that genus, in having a larger number of lateral setae on the labium (10–11), in having the abdomen a little narrowed beyond the sixth segment, and the dorsal hooks on segments 5-8 sharply bent posteriorly just above their bases, and long—as long as their respective segments—and very sharp.

Our two species may be separated by the following keys.

KEY TO SPECIES OF LEUCORHINIA

Imagos

a Inferior appendage of the males bifurcated; generally, a yellow twin spot on the dorsum of the seventh abdominal segment; females with the two lobes of the vulvar lamina long and slender, each much longer than wide ..... intacta

aa Inferior abdominal appendage of the male not bifurcated, with only a shallow angular notch in its end, no twin spot on segment 7; vulvar lamina of the female with its two lobes little developed, much shorter than broad ..... glacialis

Nymphs

a Dorsal hook of the eighth abdominal segment directed straight posteriorly at its apex; lateral setae 10 ..... intacta

aa Dorsal hook of the eighth abdominal segment strongly declined at its tip; lateral setae 11 resting on the dorsum of the ninth segment ..... glacialis

Leucorhinia intacta Hagen

White face

1861 Diplax intacta Hagen, Synopsis Neur. N. Am. p. 179

1890 Leucorhinia intacta Calvert, Am. ent. soc. Trans. 18:39, pl. 5, fig. 1, 7–9

1890 Leucorhinia intacta Hagen, Am. ent. soc. Trans. 17:235, pl. 10, fig. 6, 8, 15, 16 and 23

1893 Leucorhinia intacta Calvert, Am. ent. soc. Trans. 20:262

1895–97 Leucorhinia intacta Calvert, N. Y. ent. soc. Jour. 3:48 and 5:94 (listed from Center, Keeseville, Ithaca, Westchester co., Croton on Hudson, Niagara river, etc.)

1899 Leucorhinia intacta Kellicott, Odon. Ohio, p. 106 (description)

1900 Leucorhinia intacta Williamson, Dragon flies Ind. p. 321 (description)

This species was not observed at Saranac Inn, but it is very common at Ithaca in the marshy flats below the city, at the head of Cayuga lake and in the shallow ponds between McLean and Freeville N. Y., where I have collected the nymphs in great numbers. I have observed the female imagos ovipositing in two quite different ways: descending and striking the water with the tip of the abdomen while in flight after the manner most common among Libellulidae, and at rest on some vertical stem at the surface of the water, plying with the tip of the abdomen just below the surface. In both cases the female was unattended by the male.

Nymph. Total length 17.5 mm; abdomen 10 mm; hind femur 5 mm; width of head 5 mm, of abdomen 6.5 mm.

In coloration the body shows generally very distinctly the following marks, besides others less distinct and constant. There is the usual black band across the head including the eyes, and the usual rings of brown are on the legs, and oblique stripes on the sides of the thorax; there is a pair of black bands emerging from beneath the tips of the wing cases, and extending to the sides of the 10th abdominal segment; there is a submedian, double row of round dots on the ventral side, running the length of the abdomen; and between these and the lateral margins of the abdomen there are two blackish, interrupted bands, one on each side.

The labium is ample, and has 10 lateral setae, and about 13 mental setae, of which the sixth (counting from the side) is longest; the teeth are obsolescent, but still distinctly crenate in form, and armed with several spinules each; the abdomen is widest across the sixth segment, narrowing slowly to the eighth segment, and then suddenly narrowed at the ninth; the lateral spines of the eighth segment surpass the middle of the ninth segment on its dorsal side; those of the ninth segment about attain the level of the tip of the superior appendage; the lateral appendages are half as long as the inferiors, and these exceed the superior a little; dorsal hook of the third segment very minute, erect; that of the fourth segment erect also but larger, the remaining hooks of more nearly equal size, laterally flattened, and above their bases strongly bent posteriorly, the tip of the hook of the eighth segment being scarcely more declined than the tip of the hook of the segment before it.

Leucorhinia glacialis Hagen

Plate 10.

1890 Leucorhinia glacialis Hagen, Am. ent. soc. Trans. 17:234, pl 10, fig. 3 and 14

This species has been known hitherto from a few male specimens collected at Cape Breton, N. S., London, Ont.; Michipicoten on Lake Superior; Reno, Nev.; and in the White mountains of New Hampshire. It has not been recorded from New York state, but I found it common at Saranac Inn. During the first week or two of adult life, before age and pruinosity have obscured its remarkably fine coloration, it is a singularly beautiful insect. One who sees only preserved specimens would not suspect this however, for in such, faded browns have replaced the ruby red color of the males and the brilliant yellow of the females. I well remember with what delighted surprise I greeted my first specimen. It was a young male, with a brilliant red body phalerate with jet black, a flavescent tinge beyond the basal markings of the wings, a rich red-brown stigma, with a touch of yellow on the costa either side of it, and a face with the whiteness and subopaqueness of fine china. That specimen was captured beside the Inn road in the last week of June; soon afterward I found plenty of them—females as well—about the bog pond that lies near this road south of the station; they were flying with Cordulia shurtleffi, Dorocordulia libera, and Lestes eurina —a group of rare beauties.

Early in July I found them commonly about the outlet of Little Clear pond, and there obtained nymphs (which later were reared), saw the females ovipositing and obtained the eggs.

Female imago (hitherto undescribed; pl. 10, fig. 3). Length 34 mm; abdomen 23 mm; hind wing 25 mm.

Similar to the male, with only the middle half of the labium black, the sides white (I have a small male that is so, also); face opaque white. Thorax and basal segments of the abdomen brilliant yellow in life, phalerate with black; the middorsal thoracic stripe of black constricted above, dilated below; a short, not very distinct, isolated humeral stripe of black; complete stripes that are broad and irregular on the humeral and third lateral sutures, and an oblique lateral stripe crossing the midlateral suture and joining the humeral stripe; a black mark on the mesothoracic spiracle; dorsal and lateral yellow areas almost enveloping the basal abdominal segments, but isolated on the first and second segments, fused on the third, which is all yellow except an apical ring and a mark at each side below; there is a yellow dorsal mark on the fourth segment, and there are dorsal yellow triangles on segments 5–7; there is also a lateral yellow basal triangle on each side of the fourth segment. The wings have the basal marking and the yellow

points at the ends of the stigma as in the male, but they are more flavescent in their basal half. The vulvar lamina is very short, being very much broader than long, with a quadrangular excavation in the middle separating its two low lobes widely; far beyond the apices of these two lobes and near the middle of the venter of the ninth segment there is a pair of minute, erect quadrangular prominences; the apical margin of the venter of the ninth segment is very convex.

I observe in my specimens considerable variation in the size of the males: 32 to 37 mm in length; the genitalia, however, are quite constant in form and agree well with the figures by Hagen cited above.

Nymph. (Pl. 10, fig. 1, 2) Total length 18 mm; abdomen 10 mm; hind femur 5.5 mm; width of head 5.5 mm, of abdomen 6.7 mm.

Unfortunately, I obtained but few nymphs, and reared them all, so that I have nothing left but the cast skins for description; these do not preserve well the nymphal color pattern when dry; there is enough of it left to show that the coloration is similar to that of L. intacta described above, though probably not so well marked. The nymph is so very similar to the preceding, it is hardly worth while to repeat the description in detail. The more salient points are as follows. The lateral setae are 11; the mental setae about 13, of which the sixth (counting from the side) is longest; the lateral spines of the eighth abdominal segment are a trifle longer than half the dorsal length of the ninth segment, the lateral spines of the ninth segment attain to the level of the tips of the inferior appendages, which are scarcely longer than the superior appendage. The dorsal hooks are as described above for L. intacta; excepting that the apex of the hook of the eighth segment is declined so that it rests at its apex on the dorsum of the ninth segment.

This last and most distinctive character between the two species is shown by some nymphs which were collected for me by Chester Young at Ellenville N. Y., May 30, 1897. These, from the Catskills, may be the nymphs of L. glacialis also; but, among so many species so much alike, and so few of them bred, they can not be so determined with certainty as yet.

The eggs are roundish oval, with a moderate investment of gelatin. They are white at first, but turn a pale lemon yellow after a number of hours. They are dropped by the female in flight in the little clear pools along shore, strewn over the bottom with hemlock leaves.

SYMPETRUM

This large genus is represented in New York state by seven nominal species, and an eighth is regional. Most of these species are exceedingly common along marshy shores and in wet meadows. The imagos travel often considerable distances from the water, and at the proper season are met with on upland meadows very commonly. Because of their familiar habits and their strikingly brilliant red coloration, they are very well known.

The nymphs are very like those of Leucorhinia, specially the species placed first in our list; but they are (except S. corruptum)

of smaller size and have the dorsal hooks of the abdomen less developed. The following keys will serve for the separation of our imagos and also of the nymphs as far as I have been able to find any differences between them.

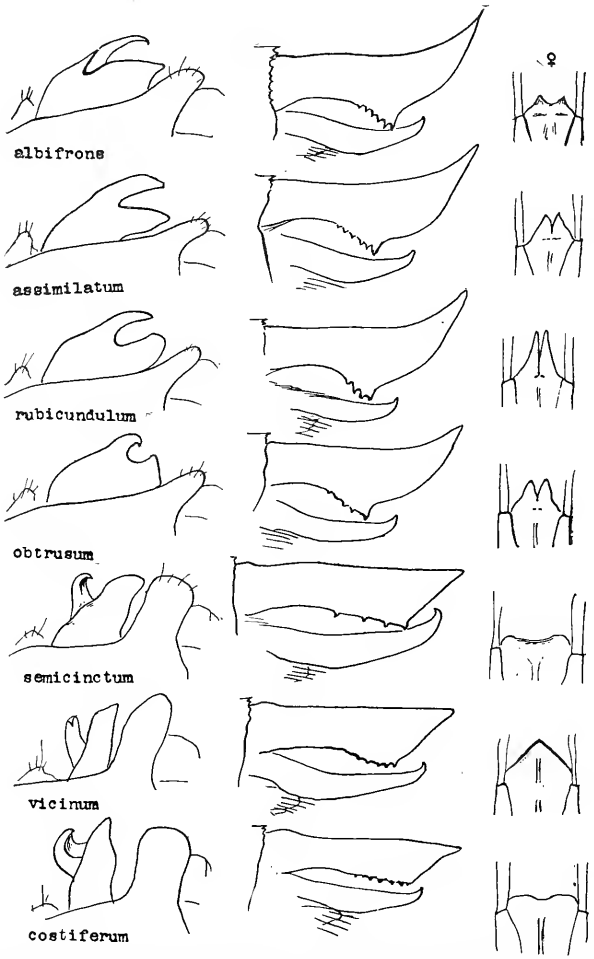

Fig. 30 Genitalia of the New York species of Sympetrum (excepting S. corruptum Hagen); first column, external view of the male genital hamule; second column, lateral view of male abdominal appendages; and third column, ventral view of vulvar lamina of the female, for the species named in the figure

KEY TO SPECIES OF SYMPETRUM

Imagos

a With a median transverse ridge incircling the fourth abdominal segment (in addition to the normal apical ridge)..... corruptum

aa With no such added ridge on the fourth abdominal segment

b Superior appendages of the male with a prominent median inferior tooth, having some denticles before it; vulvar lamina of the female divided by a median cleft into two pointed lobes

c Tibiae and tarsi yellow externally; the black of the abdominal segments tending to form apical rings ..... albifrons

cc Tibiae and tarsi wholly black; the black of the abdominal tending to form apical lateral triangles

d Wings with the basal half (or somewhat less) flavescent; branches of the genital hamule of the male inclosing an angular notch; vulvar lamina of the female with its lobes short and sharply recurved upward, their apices meeting the venter of the ninth segment vertically assimilatum

dd Wings flavescent only at the extreme base; branches of the genital hamule of the male inclosing an oval or a rounded notch; vulvar lamina of the female with appressed lobes which meet the venter of the ninth segment more obliquely

e Branches of the genital hamule of the male inclosing an oval notch, the outer about twice as stout as the inner, about equally curved; the vulvar lamina of the female with its sides regularly sloping rubicundulum

ee Branches of the genital hamule of the male inclosing a short rounded notch, the inner branch more sharply incurved, the outer about four times as thick as the inner; the vulvar lamina of the female somewhat contracted at about midway its length, the sides more convergent in the basal half..... obtrusum

bb Superior abdominal appendage of the male without a prominent inferior median tooth, but only with small inferior denticles of about equal size; vulvar lamina of the female not cleft

c Wings with the basal half flavescent..... semicinctum

cc Wings flavescent only at the extreme base

d Femora and tibiae entirely yellow ..... vicinum

dd Femora and tibiae marked with black on the sides..... costiferum

Nymphs[1]

a Dorsal hooks of abdominal segments 6–8 long and sharp, about as long as their respective segments

b Lateral spines straight on both outer and inner margins.... costiferum

1 The nymphs of albifrons and corruptum are unknown; that of the former species is likely to be of the type of the nymph of rubicundulum. I give a figure (pl. 25, fig. 1) of a nymph from southern California of S. illotum, the nearest ally of corruptum. The nymph of corruptum will probably be of this type.

I have nymphs of rubicundulum raised at Ithaca, of obtrusum, raised at Lake Forest Ill., and of assimilatum raised at Saranac Inn. Between the nymphs of rubicundulum and obtrusum I find only a scarcely perceptible difference in size, that of obtrusum being a little smaller, in the bred specimens. Both these are a very little smaller than assimilatum; and I note that in the bred specimens the dorsal hooks on the fourth and fifth abdominal segments (hidden between the wing cases) are larger and more nearly equal in size in assimilatum, smaller and more unequal in size and paler in the other two. These differences are so slight and have been studied in so few specimens that I have not thought best to introduce them as yet into the table.

As to the imagos of these three nominal species, I know of no absolutely constant differences either in size, coloration, structure, distribution or habits that will in every case distinguish between them. The typical rubicundulum is of course, intermediate between the other two. I have examined hundreds of specimens of each, and say unhesitatingly that they intergrade completely; nevertheless, it is convenient to recognize the three forms, and practically, there is little difficulty generally in distinguishing between them. I have therefore listed them separately.

bb Lateral spines of the ninth segment straight on the inner, but incurvate on their outer margins

c Lateral spines of the eighth segment thin, flat and sharp, attaining the level of the apical margin of the ninth segment on the middorsal line vicinum

cc Lateral spines of the eighth segment stouter, their tips hardly surpassing the middle of the dorsum of the ninth segment..... semicintum

aa Dorsal hooks of abdominal segments 6–8 shorter than the segments bearing them, and less pointed. assimilatum, rubicundulum, obtrusum

Sympetrum costiferum Hagen

Figure 30

1861 Diplax costifera Hagen, Synopsis Neur. N. Am. p. 175

1895 Diplax costifera Calvert, N. Y. ent. soc. Jour. 3:48 (listed from Amherst)

This species came up quite unexpectedly in one of my breeding cages at Saranac Inn. I had collected a number of nymphs from the shore of Little Clear pond near the outlet, and put them in this cage, supposing them to be of one species; they yielded at transformation imagos of S. vicinum, but one nymph yielded a fine male specimen of this species. It is the one from which the characters stated herewith are drawn. No imagos were seen at large. This one appeared on August 8. The cast skin was left in a somewhat collapsed condition, so that it is hard to measure accurately; but the measurements are, as nearly as I can make out, as follows: total length 14.5 mm; abdomen, 9 mm; hind femur 5 mm; width of head 5 mm, of abdomen, 6 mm.

The eyes are a trifle less prominent than in S. vicinum; there are 11 lateral setae, and about 13 mental setae, of which the fifth, counting from the side, is longest, the movable hook is somewhat shorter and thicker than in S. vicinum, and the teeth are more nearly obsolete; the lateral spines of the eighth abdominal segment are about half as long as is that segment; those of the ninth segment are much longer, slender, straight on both margins, and their tips scarcely attain the level of the tips of the appendages. The superior appendage is scarcely shorter than the inferiors, but these laterally are less than one half as long.

Sympetrum vicinum Hagen

Figure 30

1861 Diplax vicina Hagen, Synopsis Neur. N. Am. p. 175

1893 Diplax vicina Calvert, Am. ent. soc. Trans. 20:264 (description and figure)

1895–97 Diplax vicina Calvert, N. Y. ent. soc. Jour. 3:48 and 5:94 (listed from Lake St Regis, Keeseville, Dobbs Ferry, New York, Ithaca, Catskill mountains, Schoharie, Piseco lake and Buffalo)
1899 Diplax vicina Kellicott, Odon. Ohio, p. 110 (description and figure)
1900 Diplax vicina Williamson, Dragon flies Ind. p. 323

This pretty, little, yellow-legged, autumnal species is likely to be found about every marsh-bordered pond in the state. It flits about the shore vegetation and is not at all difficult to capture with a net. At Cascadilla pond near Ithaca I have watched the females ovipositing on beds of wet and matted dwarf club-rush, sometimes alone, but oftener held by the male, both descending together and rising every time the tip of the abdomen was brushed against the wet mats. Some eggs obtained in September at Ithaca hatched the following January, having been kept the while in a laboratory of the normal temperature. Doubtless, under normal conditions they do not hatch before spring.

Nymph. Total length 13 mm; abdomen 8 mm; hind femur 4.5 mm; width of head 4.5 mm, of abdomen 5 mm.

The eyes are a little more prominent laterally than in other members of the genus; the lateral setae are nine; mental setae about 12 or 13, the fifth (counting from the side) longest; the movable hook is excessively long and slender; the superior appendage is one third shorter than the inferiors, and the laterals less than one half as long as the inferiors.

At Saranac Inn, the nymphs were found at the north side of the outlet of Little Clear pond, on the shelving bank behind the hummock of cattails. They are rather daintily colored with bands of black across the head, including the eyes, around the femora, and across the middle of the abdominal segments. They clamber about amid the semiaquatic vegetation.

Sympetrum semicinctum Say

Figure 30

1839 Libellula semicincta Say, Acad. nat. sci. Phil. Jour. 8:27
1861 Diplax semicincta Hagen, Synopsis Neur. N. Am. p. 176
1893 Diplax semicincta Calvert, Am. ent. soc. Trans. 20:263 (description and figure)
1895 Diplax semicincta Calvert, N. Y. ent. soc. Jour. 3:48 (listed from Ithaca, Staten Island, Westchester co.)
1899 Diplax semicincta Kellicott, Odon. Ohio, p. 110 (description and figure)
1900 Sympetrum semicinctum Williamson, Dragon flies Ind. p. 324 (description and figure)

This species, which I have observed at Ithaca, and have bred in Illinois, did not appear at Saranac Inn. It is quite like the others of the genus. I have observed the female ovipositing alone in muddy pools among dead smartweed stems on a mud flat beside a pond.

Nymph. (Pl. 25, fig. 2) Of much the same form as that of S. vicinum, but a little larger (at the time of writing this I have not my specimens at hand for reference, and can not therefore give the exact measurements; I have all the other details carefully recorded in note and drawings, but the measurements have been accidentally omitted); the eyes are laterally prominent, but well rounded; lateral setae nine; mental setae about 12, of which the fifth (counting from the side) is longest; the dorsal hooks on the fourth and fifth abdominal segments are less than one third as large as those on the three following segments; the superior abdominal appendage is one fourth shorter and the laterals are one half shorter than the inferiors; the spines of the ninth segment surpass the apices of the superior appendage, and are strongly incurved, and spinulose serrate on their exterior margins.

Sympetrum assimilatum Uhler

Figure 30

1857 Libellula assimilata Uhler, Acad. nat. sci. Phil. Proc. p. 88
1893 Diplax rubicundula var. assimilata Calvert, Am. ent. soc. Trans. 20: 263
1899 Diplax rubicundula Kellicott, Odon. Ohio, p. 109 (description)

This was very common at Saranac Inn in Little Clear creek. During the latter part of July the nymph could be seen any clear morning climbing up the Sparganium stems, and transforming. The nymphs were obtained whenever collecting was done from the beds of standing vegetation along the creek.

Sympetrum rubicundulum Say

Figure 30

1839 Libellula rubicundula Say, Acad. nat. sci. Phil. Jour. 8: 26
1861 Diplax rubicundula Hagen, Synopsis Neur. N. Am. p. 176
1866 Diplax rubicundula Scudder, Bost. soc. nat. hist. Proc. 10: 219
1893 Diplax rubicundula Calvert, Am. ent. soc. Trans. 20: 262 (description)
1899 Diplax rubicundula Kellicott, Odon. Ohio, p. 109 (description)
1900 Diplax rubicundula Williamson, Dragon flies Ind. p. 322 (description)

Pale, teneral, yellowish specimens of this species begin fluttering up out of the grasses that fill the shallow water in the upper reaches of most ponds about the latter end of June. A month later, when they have assumed their brillant black and red coloration, and have become more numerous, we find them scattered everywhere. They seem most numerous, however, about wet meadows, where they delight to go foraging.

The nymph, like that of the preceding and that of the following species (the only differences that I have observed between these I have already stated in a footnote to the nymph table) has nine lateral setae, and 12 mentals, of which the fifth (counting from the side) is longest; the dorsal hooks on segments 4–8 are low, less considerable in length than the segments which bear them, but sharp; the lateral spines of the eighth and ninth segments are less developed, and follow in their external contour the incurvate lines of the posteriorly narrowing abdomen; the lateral appendages are half as long as the inferiors, which are distinctly longer then the superior.

Sympetrum obtrusum Hagen

Figure 30

1867 Diplax obtrusa Hagen, Stett. ent. zeit. 28: 95
1893 Diplax obtrusa Calvert, Am. ent. soc. Trans. 20: 264 (description and figure)
1899 Diplax obtrusa Kellicott, Odon. Ohio, p. 109 (description and figure)
1900 Diplax obtrusa Williamson, Dragon flies Ind. p. 323 (description)

For this and the two foregoing species I have hardly thought it worth while to state the distribution in detail, it is so general throughout the state, whenever any collecting has been done.

Sympetrum albifrons Charpentier

Figure 30

1841 Libellula albifrons Charpentier, Lib. Europ. p. 81, pl. 11, fig. 3
1861 Diplax albifrons Hagen, Synopsis Neur. N. Am. p. 177
1900 Sympetrum albifrons Williamson, Dragon flies Ind. p. 323 (description)

Not yet found in the state; nymph unknown.

Sympetrum corruptum Hagen

1861 Mesothemis corrupta Hagen, Synopsis Neur. N. Am. p. 171
1893 Diplax corrupta Calvert, Am. ent. soc. Trans. 20: 264 (description)
1897 Diplax corrupta Calvert, N. Y. ent. soc. Jour. 5: 95 (listed from Staten Island)
1897 Diplax corrupta Van Duzee, N. Y. ent. soc. Jour. 5: 91 (listed from Lake Erie)
1899 Diplax corrupta Kellicott, Odon. Ohio, p. 111 (description)
1900 Diplax corrupta Williamson, Dragon flies Ind. p. 324 (description)

This species is much more common westward; its nymph is unknown.

PACHYDIPLAX

There is a single species.

Pachydiplax longipennis Burmeister

1839 Libellula longipennis Burmeister, Handb. ent. 2:850
1861 Mesothemis longipennis Hagen, Synopsis Neur. N. Am. p. 173
1893 Pachydiplax longipennis Calvert, Am. ent. soc. Trans. 20:265
1895–97 Pachydiplax longipennis Calvert, N. Y. ent. soc. Jour. 3:48 and 5:94 (listed from New York, Westchester co., Ithaca and Blackrock)
1899 Pachydiplax longipennis Kellicott, Odon. Ohio, p. 114 (description)
1900 Pachydiplax longipennis Williamson, Dragon flies Ind. p. 326 (description)

This is a species of very wide distribution. It has been recorded from most regions of North America, south of the Canadian, from Mexico, and from the Bahama islands, and last summer Dr O. S. Westcott, stopping to visit our station on his return from the Bermuda islands, brought a number of specimens collected in that new quarter. The species was not observed at large at Saranac Inn. It is likely to be found rather generally distributed throughout the state at lower altitudes.

Imagos of this species are swift of wing, and somewhat difficult to capture with a net. The males hover near the surface of the water, darting hither and thither, meeting every newcomer, perching on a twig and immediately quitting it; and, when two males meet in combat, they have the curious habit of darting upward together into the air and flying skyward, often, till lost from view. The females are less in evidence. They rest habitually, except when foraging or ovipositing on trees back from the shore. When ovipositing over open water, they have a curious habit which I have not observed in other dragon flies: they do not rise and descend again between strokes of the end of the abdomen against the surface of the water, but fly along horizontally close to the surface and from time to time strike downward with the abdomen alone, presumably washing off the eggs. In the midst of vegetation, however, they fly down and up again, as do other species.

The nymphs clamber about among the trash, and, when grown, transform within a few inches of the margin of the water, if suitable place be found so near; otherwise they may go a distance of several feet. They are smooth, generally of dark color, with little pattern of color showing, except in the transverse banding of the femora.

Nymph. Total length 21 mm; abdomen 12 mm; hind femur 6 mm; width of head 6 mm, of abdomen 7.5 mm.

Easily recognizable among other libelluline nymphs (when well grown at least) by the head twice as wide as long, the entire absence of dorsal hooks, the smooth and depressed body, and by the superior appendage being one third shorter than the inferiors and twice as long as the laterals. The labium is large, and the median lobe is at its maximum size; hook long and slender; laterals 10; mentals about 12, the fifth or sixth (counting from the side) longest; the lateral spines of the eighth and ninth segments of the abdomen are very similar in size and shape, those of the ninth segment extending posteriorly almost to the level of the tips of the inferior appendages.

MESOTHEMIS

There is a single species occurring within the state.

Mesothemis simplicicollis Say

1839 Libellula simplicicollis Say, Acad. nat. sci. Phil. Jour. 8:28

1861 Mesothemis simplicicollis Hagen, Synopsis Neur. N. Am. p. 170

1893 Mesothemis simplicicollis Calvert, Am. ent. soc. Trans. 20:265 (description)

1895–97 Mesothemis simplicicollis Calvert, N. Y. ent. soc. Jour. 3:48 and 5:94 (listed from New York, Westchester co., Ithaca and Towanda creek)

1899 Mesothemis simplicicollis, Kellicott, Odon. Ohio, p. 113 (description)

1900 Mesothemis simplicicollis, Williamson, Dragon flies Ind. p. 325

This is another species of wide distribution, that is much more common southward and westward: a single specimen was seen at Saranac Inn. I remember having seen but very few at Ithaca. I bred this species and P. longipennis in Illinois in 1895. The imagos of this species have more of the gomphine habit of squatting on the ground than any other libellulines known to me. That may be the meaning of the long spines on the hind femora. They do not seek the topmost twigs of reeds, as do most other shore-frequenting species, but settle by preference in some bare path, or aslant a board at the edge of the water. The nymphs are rapid climbers among reed stems. In life their eyes are yellowish externally, and the teeth on the edges of the labial lobes are white. The bodies of the nymphs are greenish with little pattern showing.

Nymph. Measures in total length 17 mm; abdomen 9 mm; hind femur 5 mm; width of head 5 mm, of abdomen 5.5 mm.

It is recognizable at a glance among all other libelluline nymphs known to me by the thickness of the body, the bulging prominence of the eyes, the relative brevity of the abdomen, and the decurved appendages at the apex of the abdomen.

The median labial lobe is very prominent; the teeth on the edges of the lateral lobes are obsolete; the lateral setae are eight, and of these the proximal one is a small one; the mental setae are about 13, of which the eight outermost are a series of larger size. There are no dorsal hooks, but there are some coarse hairs on the transverse apical carinae of the segments, and there is a long brush of these springing from the apical ventral margin of the ninth segment; there are no lateral spines, or the merest vestiges of them remain sometimes on the ninth segment: the appendages are all decurved, the inferiors most strongly; the superior is a little shorter than the inferiors, a little longer than the laterals; the prothoracic spiracles are elevated to the highest point of the body. So unique are a number of these characters, there is no confusing this nymph with the others of the subfamily.

MICRATHYRIA

A single species of our fauna is referred to this genus.

Micrathyria berenice Drury

1773 Libellula berenice Drury, Illus. exotic ent. v. 1, pl. 48, fig. 3
1839 Libellula berenice Say, Acad. nat. sci. Phil. Jour. 8:25
1861 Diplax berenice Hagen, Synopsis Neur. N. Am. p. 178
1867 Diplax berenice Packard, Am. nat. 1:311, pl. 9, fig. 3 and 4
1893 Micrathyria berenice Calvert, Am. ent. soc. Trans. 20:260 (description)
1895-97 Micrathyria berenice Calvert, N. Y. ent. soc. Jour. 3:47 and 5:94 (listed from Thousand Islands, New York and Sheepshead bay, L. I.)

This is a species I have never seen alive. It is said to be common down the valley of the Hudson. Its nymph is unknown.

LADONA

Of the three forms comprising this genus, originally described as distinct species, two probably occur within the limits of New York state. In what I have written concerning these hitherto, I have followed without question the synonymy as given by Hagen and Calvert, according to which both deplanata of Rambur and julia of Uhler are but varieties of exusta Say, not even bearing a varietal name. A. P. Morse has called my attention to some facts which seem to indicate that these three may yet have to be considered as distinct species. I may add that my breedings have furnished farther facts corroborating this opinion.

Before the "lumping" process began the bibliography of these forms was as follows.

1839 Libellula exusta Say, Acad. nat. sci. Phil. Jour. 8:29
1842 Libellula deplanata Rambur, Ins. Neur. p. 75
1857 Libellula julia Uhler, Acad. nat. sci. Phil. Proc. p. 88

Then Hagen, in his *Synopsis of the Neuroptera of North America* (1861), ranked deplanata and exusta as synonymous (under the later name, however); in his *Synopsis of the Odonata of America* (1875) he ranked them separately, remarking that deplanata was probably but a dwarf southern form of exusta, but he wrote down julia as a synonym of exusta. In 1893 Calvert in his *Odonata of Philadelphia and vicinity* again added deplanata to the exusta lump. The three have been treated as one ever since, and in all recent descriptions and lists, dimensions, coloration, structural characters and distribution are hopelessly confused; and it becomes necessary to revert to the original descriptions to find statement of differences between them.

The two which concern us here in New York are L. exusta Say and L. julia Uhler. So far as I am able to judge by my own specimens and by those in the Museum of comparative zoology at Cambridge, these seem to be distinguished by the following characters.

a Dorsum of the thorax pale with a black stripe each side on the humeral suture, no ante-humeral stripe of white; the fuscous spot on the base of the hind wing not enveloping the triangle; the eighth abdominal segment of the male narrower than the seventh; the apex of the anterior branch of the genital hamule of the male directed laterally ..... julia

aa Dorsum of the thorax blackish brown, with a white ante-humeral stripe each side; the fuscous spot of the hind wing envelops the triangle; the eighth abdominal segment in the male is as wide as or wider than the seventh; the apex of the anterior branch of the genital hamule of the male is directed posteriorly ..... exusta

I have described in the *Canadian entomologist* for 1897 (29:144–46) the nymphs of deplanata from Florida. These differ from the nymphs of L. julia described below by some unusually good specific characters, such as the entire absence of raptorial setae from the median lobe of the labium, and the hooked teeth on the margin of the lateral lobes. It remains now to discover the nymph of exusta, and to learn whether deplanata agrees with it.

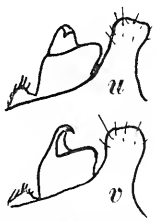

Fig. 31 Male genital hamules of Ladona julia Uhl. (*u*) and L. exusta Say (*v*)

It will be observed that the characters given in the generic table for nymphs at the beginning of this subfamily abundantly justify the erection of Ladona as a genus separate from Libellula.

L. exusta is recorded in Calvert's list of the Odonata of New York state from Lake George, and Croton on Hudson. Whether the record be for exusta or for julia, is uncertain. The characters given above will I trust, enable the collector in the future to distinguish between these

two; and if some collector find the typical exusta to be common, he may aid the farther solution of this question by setting about to find its nymph. I discuss below the single form which I have found within the state.

Ladona julia Uhler

1857 Libellula julia Uhler, Acad. nat. sci. Phil. Proc. p. 88
1861 Libellula julia Hagen, Synopsis Neur. N. Am. p. 153
1867 Libellula julia Hagen, Stett. ent. zeit. 28:192

This species was very common at Saranac Inn. It was beginning to appear in numbers on the wing at the time of our arrival, June 13. I went out to the banks of Little Clear pond at sunrise of the morning of the 14th and found a number of nymphs transforming, associated with Tetragoneuria. The imagos were abundant along every roadside during the month of June, and females were only a little less in evidence than the males. Nymphs were taken abundantly from the trashy places in the borders of Little Clear and Bone ponds, and a few were found in Little Clear creek; exuviae were seen in numbers clinging to the banks of Colby pond, and a few along Stony brook near Axton.

Nymph. Total length 24 mm; abdomen 15.5 mm; hind femur 5.5 mm; width of head 5 mm, of abdomen 5.5 mm.

Body slender, elongate, moderately hairy, dark colored, without distinct pattern, but paler on the sutures and below.

Head somewhat wider than long, with eyes not very prominent, and hind margin slightly concave; median lobe of the labium with a median flat, toothlike prominence in the middle of its free border, on either side of which the border is crenulate, with spinules inserted singly in the notches between the crenulations; lateral setae six; hook slender, and not very long; mental setae three each side.

Abdomen with sharp lateral spines, relatively shorter than on the nymph of deplanata; dorsal hooks on segments 4–8 straight and sharp; superior and inferior appendages of about equal length, and about as long as the last two abdominal segments; lateral appendages one fifth to one fourth as long as the others.

The presence of three mental setae on the labium will distinguish this species at a glance from the nymph of L. deplanata of the south.

LIBELLULA

This genus contains the species which are, perhaps, the best known of all our dragon flies. The imagos hover habitually over ponds in summer, are large, and for the most part beautifully colored, and are everywhere common. Eight species are known from the state, and it is not likely that any others will be found resident in numbers. It is of course always possible for a few strays to be blown into new territory from distant regions by high winds. The nymphs of five of these eight species are

known, and are described and distinguished below. So much alike are they that a general account of the nymphal characters will save much restatement.

The known nymphs of this genus agree in having the body elongate, tapering to the pointed apex of the abdomen, hairy, the hairs serving to hold an ambuscade of silt about the body. Head compact, little wider than long, with the eyes capping the anterolateral angles, and directed anteriorly; head little narrowed behind the eyes; labium large, reaching posteriorly between the bases of the middle legs; median lobe with its front border not crenate; mental setae always present, variable in number; lateral setae five to nine; prothorax with a flatish dorsal shield, whose margins are generally fringed with coarse hairs; wing cases reaching the base of the sixth abdominal segment; abdomen triquetral, its lateral margins becoming acute posteriorly, with short lateral spines on segments 8 and 9; a variable number of dorsal hooks beginning on the third or fourth segment, sometimes quite rudimentary; ninth segment two to three times as long as the 10th; lateral appendages half as long as the others; tarsi with the second and third joints successively each a very little longer than the first.

The imagos discussed below, and the known nymphs of the same species may be separated by the following keys.

KEY TO SPECIES OF LIBELLULA

Imagos

a Wings with no spot at the nodus

b With a broad basal band of black covering the basal third of both wings ..... basalis

bb With the black color of the base of the wings confined to a narrow streak in the subcostal space, or entirely wanting

c Stigma bicolored

d Inner half of stigma white or yellow, outer half dark brown. ..... cyanea

dd Stigma mainly yellow, but distinctly darker at the outer end ..... plumbea

cc Stigma not differing in color at its inner and outer ends

d Stigma red or yellow; wings flavescent, unspotted..... auripennis

dd Stigma black ..... incesta

aa Wings with a small nodal spot which is restricted to the outer (distal) side of the nodus

b With a large triangular patch of black extending from the triangle to the hind margin ..... quadrimaculata

bb Without a black patch between the triangle and the hind margin in the hind wing ..... vibrans

aaa With a large nodal spot which completely surrounds the nodus

b Nodal and apical wing spots yellowish or reddish..... semifasciata

bb Nodal and apical wing spots blackish..... pulchella

Nymphs

a Dorsal hooks on the seventh and eighth abdominal segments long and sharp
b Lateral setae five ..... auripennis
bb Lateral setae six ..... cyanea
bbb Lateral setae seven ..... basalis
aa Dorsal hooks on the seventh and eighth abdominal segments rudimentary (and hidden among scurfy hairs) or wanting
b Lateral setae seven ..... quadrimaculata
bb Lateral setae eight to nine ..... pulchella
aaa Nymphs unknown
axillena, plumbea, incesta and semifasciata

Libellula basalis Say

1839 Libellula basalis Say, Acad. nat. sci. Phil. Jour. 8:23
1839 Libellula luctuosa Burmeister, Handb. ent. 2:861
1861 Libellula luctuosa Hagen, Synopsis Neur. N. Am. p. 152
1875 Libellula basalis Hagen, Bost. soc. nat. hist. Proc. 18:70
1893 Libellula basalis Calvert, Am. ent. soc. Trans. 20:255 (description)
1895–97 Libellula basalis Calvert, N. Y. ent. soc. Jour. 3:47 and 5:94 (listed from Dobbs Ferry, Ithaca, Kenwood, Niagara river)
1899 Libellula basalis Kellicott, Odon. Ohio, p. 96 (description)
1900 Libellula basalis Williamson, Dragon flies Ind. p. 329

This is not one of the more common species apparently in New York state. I have taken a few specimens at Ithaca; I saw one imago at Saranac Inn, and took one nymph there. I studied and reared the species in 1895 at Galesburg Ill., where it is abundant. Of a June morning half an hour after sunrise, I have seen scores of the nymphs transforming at a time on the blue-grass bordered banks of a little pond.

Nymph. Total length 25 mm; abdomen, 14 mm; hind femur 5.5 mm; width of head, 5.5 mm, of abdomen, 6.5 mm.

The points which will chiefly serve for comparison with other species are as follows: body not very hairy, generally dirty and showing little color pattern; lateral setae, seven; mental setae about 10 or 11, the outer five or six in a longer series; movable hook, long, slender, little curved; dorsal hooks on abdominal segments 4–8 all sharp and well exposed, but the sixth longest.

Libellula auripennis Burmeister

Golden-wing

1839 Libellula auripennis Burmeister, Handb. ent. 2:861
1861 Libellula auripennis Hagen, Synopsis Neur. N. Am. p. 155
1866 Libellula auripennis Scudder, Bost. soc. nat. hist. Proc. 10:191
1893 Libellula auripennis Calvert, Am. ent. soc. Trans. 20:256 (description)

1895 Libellula auripennis N. Y. ent. soc. Jour. 3:47 (listed from the vicinity of New York)
1899 Libellula auripennis Kellicott, Odon. Ohio, p. 97 (description)
1900 Libellula auripennis Williamson, Dragon flies Ind. p. 329 (description)

This beautiful, golden-winged, southern species is not likely to be found in the state except near the coast. A few years ago Prof. A. L. Quaintance reared the species at Lake City Fla., and very kindly sent me the bred specimen with its cast skin, and some nymphs in alcohol. I have several times since received the nymphs from other localities in the south. I have not seen the species at large.

Nymph. Total length 27 mm; abdomen 17.3 mm; hind femur 6 mm; width of head 6 mm, of abdomen 7 mm.

The body is a trifle heavier than in the nymph of basalis and more hairy; the median lobe of the labium is decidedly pointed in the middle of its front border; lateral setae five; mental setae eight to ten, the six outer ones forming a larger series; movable hook rather stout and little curved; ninth abdominal segment twice as long on the ventral as on the dorsal side, twice as long above as the 10th segment; dorsal hooks on segments 3 or 4–8, straight, and sharp; appendages as long as the two last abdominal segments, the laterals half as long as the others.

Libellula vibrans Fabricius

1793 Libellula vibrans Fabricius, Ent. syst. 2:380
1861 Libellula lydia Hagen, Synopsis Neur. N. Am. p. 155
1893 Libellula axillena vibrans Calvert, Am. ent. soc. Trans. 20:257
1895 Libellula axillena vibrans Calvert, N. Y. ent. soc. Jour. 3:47 (listed from Staten Island and Westchester co.)
1899 Libellula vibrans Kellicott, Odon. Ohio, p. 98 (description)
1900 Libellula vibrans Williamson, Dragon flies Ind. p. 330 (description)

Another handsome, graceful, well proportioned insect, of very swift flight; apparently not common in this state. Its nymph is unknown.

Libellula incesta Hagen

1861 Libellula incesta Hagen, Synopsis Neur. N. Am. p. 155
1893 Libellula axillena incesta Calvert, Am. ent. soc. Trans. 20:257
1899 Libellula incesta Kellicott, Odon. Ohio, p. 99 (description)
1900 Libellula incesta Williamson, Dragon flies Ind. p. 330

This species has not as yet been taken in the state: it is almost sure to be found there eventually. It ranges from New Hampshire to Texas, and is said to be common in places in Ohio. Its nymph is unknown.

Libellula plumbea Uhler

1857 Libellula plumbea Uhler, Acad. nat. sci. Phil. Proc. p. 87
1861 Libellula plumbea Hagen, Synopsis Neur. N. Am. p. 157
1893 Libellula plumbea Calvert, Am. ent. soc. Trans. 20:256 (description)
1895 Libellula plumbea Calvert, N. Y. ent. soc. Jour. 3:47 (listed from Westchester co.)

This is another southern species which seems not likely to be found commonly in the state excepting possibly in the lower valley of the Hudson river. Its nymph is unknown.

Libellula cyanea Fabricius

1775 Libellula cyanea Fabricius, Syst. ent. p. 424
1839 Libellula quadrupla Say, Acad. nat. sci. Phil. Jour. 8:23
1857 Libellula bistigma Uhler, Acad. nat. sci. Phil. Proc. p. 87
1861 Libellula quadrupla Hagen, Synopsis Neur. N. Am. p. 157
1893 Libellula cyanea Calvert, Am. ent. soc. Trans. 20:556 (description)
1895 Libellula cyanea Calvert, N. Y. ent. soc. Jour. 3:47 (listed from the vicinity of New York)
1899 Libellula cyanea Kellicott, Odon. Ohio, p. 97 (description)
1900 Libellula cyanea Williamson, Dragon flies Ind. p. 330.

This species ranges from Massachusetts to Indiana and South Carolina; it is likely to be found eventually in numerous unreported localities in New York state. I have not seen it at large, but I have been allowed to study a bred specimen kindly lent me by Samuel Henshaw, and from that specimen, the following characters of the nymph are drawn.

Nymph. Total length 20 mm; abdomen 13.5 mm; hind femur 5 mm; width of head 5 mm, of abdomen 6.5 mm.

The head is considerably narrowed behind the eyes, and the hind angles are rough hairy; lateral setae six; mental setae eight or nine, the six or seven external ones forming a stronger series; the movable hook is stout, short and almost straight; dorsal hooks on abdominal segments 4–8, straight and sharp; lateral spines spinulose hairy externally, those of the ninth segment shorter than the 10th segment, 9th segment a little more than twice as long as the 10th; appendages as long as the last two segments, the lateral appendages half as long as the others.

Libellula quadrimaculata Linnaeus

1785 Libellula quadrimaculata Linnaeus, Syst. nat. 1:543
1861 Libellula quadrimaculata Hagen, Synopsis Neur. N. Am. p. 150
1867 Libellula quadrimaculata Packard, Am. nat. 1:310, pl. 9, fig. 2
1893 Libellula quadrimaculata Calvert, Am. ent. soc. Trans. 20:258
1893–97 Libellula quadrimaculata Calvert, N. Y. ent. soc. Jour. 3:47 and 5:94 (listed from New York, Ithaca, Schoharie, Karner and Buffalo)
1899 Libellula quadrimaculata Kellicott, Odon. Ohio, p. 100 (description)
1900 Libellula quadrimaculata Williamson, Dragon flies Ind. p. 331 (description)

This species occurred sparingly at Saranac Inn. A few imagos were seen sitting on twigs which rose directly a few feet out of the water. They were shy and difficult to capture, and, when disturbed, would rarely return to the same vicinity. I have not been able to find this so common species in its immature stages in person, but I have nymphs sent me from Ellenville N. Y. by Chester Young, and others from the state of Washington; these agree well with specimens from France which I have received from my esteemed correspondent, M. René Martin, of Leblanc. The nymph of this species has long been known in Europe.

Nymph. The largest Ellenville nymph, apparently full grown, measures in total length 26 mm; abdomen 18 mm; hind femur 6 mm; width of head 6 mm, of abdomen 8 mm.

The head is very compact in this nymph, scarcely narrowed behind the eyes; the median lobe of the labium is produced at the middle of its free border into a flat, toothlike prominence; lateral setae seven; mental setae about 13, of which the seven outermost are longest; movable hook slender and incurvate; the dorsum of the body is scurfy hairy (hardly less so than in L. pulchella, described below), and the hairs partly obscure the dorsal hooks which are present on segments 3–8 of abdomen, that of the eighth segment short and rudimentary; lateral spines very short; segment 10 about half as long on the dorsal as on the ventral side; appendages fully as long as the last two abdominal segments. The laterals have unusual length for a member of this genus in being but about one fourth shorter than the others.

Libellula semifasciata Burmeister

Plate 23, fig. 1

1839 Libellula semifasciata Burmeister, Handb. ent. 2:862
1861 Libellula semifasciata Hagen, Synopsis Neur. N. Am. p. 151
1839 Libellula ternaria Say, Acad. nat. sci. Phil. Jour. 8:21
1842 Libellula maculata Rambur, Ins. Neur. p. 55
1893 Libellula semifasciata Calvert, Am. ent. soc. Trans. 20:258
1895–97 Libellula semifasciata Calvert, N. Y. ent. soc. Jour. 3:47 and 5:94 (listed from New York, Dobbs Ferry and Buffalo)
1898 Libellula semifasciata Needham, Outdoor studies, p. 55, fig. 54
1899 Libellula semifasciata Kellicott, Odon. Ohio, p. 100 (description)
1900 Libellula semifasciata Williamson, Dragon flies Ind. p. 332 (description)

In the north this species is the earliest of the genus to be abroad in the spring, making its appearance before the middle of May. I have oftenest found the imago about woodland brooks—rarely about ponds. I have never found the nymph; it is still unknown.

Libellula pulchella Drury

Plate 23, fig. 2

1773 Libellula pulchella Drury, Illus. exotic ent. v. 1, pl. 48, fig. 5
1857 Libellula confusa Uhler, Acad. nat. sci. Phil. Proc. p. 87
1861 Libellula pulchella Hagen, Synopsis Neur. N. Am. p. 153
1893 Libellula pulchella Calvert, Am. ent. soc. Trans. 20: 259
1895–97 Libellula pulchella Calvert, N. Y. ent. soc. Jour. 3: 47 and 5: 94 (listed from Keeseville, Dobbs Ferry, New York, Ithaca, Schoharie and Buffalo)
1898 Libellula pulchella Needham, Outdoor studies, p. 56, fig. 55
1899 Libellula pulchella Kellicott, Odon. Ohio, p. 101 (description)
1900 Libellula pulchella Williamson, Dragon flies Ind. p. 332 (description)

This beautiful, pond-loving species is one of the best known of all Odonata peculiar to North America. The old and white pruinose males hovering over the open water under the summer sun are certainly sufficiently striking to catch the eye of the most casual observer. The species was not common at Saranac Inn. But a few specimens were seen there. I reared one specimen there, many at Ithaca (where the species is abundant) and many in Illinois.

Nymph. Total length 26 mm; abdomen 16 mm; hind femur 6 mm; width of head 6 mm, of abdomen 8 mm.

All the ridges on the dorsum of this nymph are fringed with stiff, strong, erect hairs; these are specially marked about the borders of the prothoracic shield, and on the rear of the head; the labium is rather regularly rounded on the prominent median lobe, lacking the median toothlike prominence of some of the other species; the lateral setae are eight to nine; mental setae 12–13, the seven outermost each side longest; the lateral spines are moderate; the dorsal hooks are quite distinctive, being represented only on segments 4–6, rudimentary, or sometimes wanting altogether. Among my Ithaca nymphs were a good many on which I could find no dorsal hooks at all. My Illinois specimens agree with the nymph from Peoria Ill., figured by Cabot,[1] and referred by doubtful supposition to Neurocordulia obsoleta.

PLATHEMIS

There is a single species within our limits.

Plathemis lydia Drury

Plate 21, fig. 1

1770 Libellula lydia Drury, Illus. exotic ent. 1: 112, pl. 47, fig. 4
1773 Libellula trimaculata DeGeer, Mem. ins. 3: 556, pl. 26, fig. 2
1854 —— —— Emmons, Agric. N. Y. v. 5, pl. 15, fig. 4 and 5 (no name or description)

[1] Immature state of the Odonata. pt 3, pl. 6, fig. 6.

1867 Libellula trimaculata Packard, Am. nat. 1:310, pl. 9, fig. 1
1861 Plathemis trimaculata Hagen, Synopsis Neur. N. Am. p. 149
1873 Libellula trimaculata Riley, Ins. Mo. 5th rep't, p. 14 (This article contains a woodcut of this species which has been most extensively copied in this country.)
1893 Plathemis trimaculata Calvert, Am. ent. soc. Trans. 20:259
1895–97 Plathemis trimaculata Calvert, N. Y. ent. soc. Jour. 3;47 and 5:94 (listed from New York, Dobbs Ferry, Ithaca, Schoharie, Albany and Buffalo)
1898 Libellula trimaculata Needham, Outdoor studies, p. 57 and 65, fig. 56 and 66
1899 Plathemis trimaculata Kellicott, Odon. Ohio, p. 102 (description)
1900 Plathemis lydia Williamson, Dragon flies Ind. p. 333 (description)

This is another well known, widely distributed and generally common species, which inhabits ponds and ditches generally. I present herewith (fig. 32) a figure of its nymph, which I have previously published in *Outdoor studies*. It differs from Libellula and Ladona in having the head widest behind the eyes, and from Libellula in having the front margin of the median lobe of the labium crenulate.

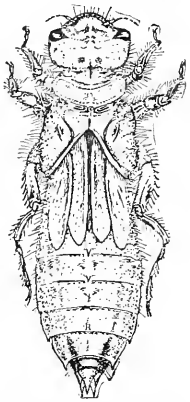

Fig. 32 Dorsal view of nymph of Plathemis lydia Dru.

Nymph. Total length 24 mm; abdomen 14 mm; hind femur 4.5 mm; width of head 4.5 mm, of abdomen 5.5 mm.

Body elongate, rather smooth, and more free from dirt than most Libellulas, generally showing two bands of blackish brown extending from beneath the tips of the wing cases to the bases of the lateral appendages. Head not widened behind the eyes, but with sides parallel; median lobe of labium prominent, but with no middle tooth on its fore margin; lateral setae 10; mental setae eight; of which the five outer ones are longer; abdomen triquetral, with moderate lateral spines on segments 8 and 9, and with rudimentary dorsal hooks on segments 3–5, highest on the fourth segment, absent from the hinder segments; lateral appendages about half as long as the equal superior and inferiors.

TRAMEA

But two species of this large genus seem to belong to the New York fauna. These are insects of superb aerial powers, representing, together with the next genus, the extreme of specialization in wing development, at least for the subfamily. Our two species may be recognized, even while in flight, by the broad, basal colored band on the hind wings. The nymphs agree in having the body smooth, depressed, unusually clean and marked with a pattern of brownish on a ground of clear transparent green;

head widest across the eyes, which are set well back toward the hind angles, the widest point being a little posterior to the middle of the head; rear of head abruptly rounded and a little concave on the hind margin; legs long, thin; tarsi with the second and third joints each twice the length of the first; abdomen strongly depressed, without dorsal hooks; dorsum smooth, with a pattern of paler mottlings on a darker ground; lateral spines of the eighth segment one and one half times as long as the body of the ninth segment, those of the ninth segment longer, reaching the level of the tips of the superior appendage; 10th segment about half as long as the ninth; appendages longer than the last two abdominal segments, superior a very little shorter than the inferiors, laterals one fourth as long; external margins of superior and inferior appendages and of the lateral spines spinulose.

These unusually attractive nymphs live in the midst of green vegetation about the shores of ponds and lakes.

Our two species may be distinguished as follows.

Imagos

a Mature coloration of the basal patch of the hind wings reddish.. carolina
aa Mature coloration of the basal patch of the hind wing blackish.. lacerata

Nymphs

a Fourth joint of the antenna three fourths as long as the third ... carolina
aa Fourth joint of the antenna one half as long as the third ..... lacerata

Tramea carolina Linnaeus

1763 Libellula carolina Linnaeus, Centur. ins. p. 28
1861 Tramea carolina Hagen, Synopsis Neur. N. Am. p. 143
1890 Tramea carolina Cabot, Immature state Odon. pt 3, p. 46, pl. 6, fig. 2
1893 Tramea carolina Calvert, Am. ent. soc. Trans. 20: 255
1895-97 Tramea carolina Calvert, N. Y. ent. soc. Jour. 3: 47 and 5: 94 (listed from New York city and Schoharie)

A large and very handsome species that is common all along our southern coast, and is distributed sparingly throughout the Mississippi valley.

Nymph. Total length 25 mm; abdomen 15 mm; hind femur 7.5 mm; width of head 7.5 mm, of abdomen 9 mm.

Save for the slightly larger size and a slightly darker general color, I can find no differences between this nymph and that of T. lacerata excepting the ones stated in the table: I find but 10 lateral setae in my nymphs of carolina, while generally there is an added shorter one at the proximal end of the row in lacerata.

Tramea lacerata Hagen

1861 Tramea lacerata Hagen, Synopsis Neur. N. Am. p. 145
1890 Tramea lacerata Cabot, Immature state Odon. pt 3, p. 46, pl. 6, fig. 1
1893 Tramea lacerata Calvert, Am. ent. soc. Trans. 20:255
1895-97 Tramea lacerata Calvert, N. Y. ent. soc. Jour. 3:47 and 5:94 (listed from Freeville and Buffalo)
1899 Tramea lacerata Kellicott, Odon. Ohio, p. 94 (description)
1900 Tramea lacerata Williamson, Dragon flies Ind. p. 316 (description)

This species is likely to be found more generally distributed through the central part and in the higher altitudes of New York state than the preceding one. It flies throughout the greater part of the season. Pairs are often seen coursing the borders of ponds and ovipositing in early spring, and in August males are often seen out on the uplands, miles from water, foraging. They are exceedingly difficult to capture; but the nymphs are often found quite abundantly and are easily reared.

Nymph. Measures in total length 24 mm; abdomen 14 mm; hind femur 7.5 mm; width of head 7.5 mm, of abdomen 9 mm.

Characters as stated for the genus: there is a middorsal paler line on the abdomen, distinguishable among the other paler markings; there is a little proximal seta on the lateral labial lobe added to the 10 that are always present in carolina; the hook is very long and slender and incurvate at end as in that species; the mental setae are 14–15, as in that species, with the outer 8 or 9 very close set and longer.

PANTALA

Our state can claim but a single species.

Pantala flavescens Fabricius

1798 Libellula flavescens Fabricius, Ent. syst. suppl. p. 285
1861 Pantala flavescens Hagen, Synopsis Neur. N. Am. p. 142
1890 Pantala flavescens Cabot, Immature state Odon. pt 3, p. 43, pl. 6, fig. 5
1893 Pantala flavescens Calvert, Am. ent. soc. Trans. 20:254
1895 Pantala flavescens Calvert, N. Y. ent. soc. Jour. 3:47
1899 Pantala flavescens Kellicott, Odon. Ohio, p. 93 (description)
1900 Pantala flavescens Williamson, Dragon flies Ind. p. 315 (description; recorded from New York state)

This cosmopolitan species is apparently rare within our limits.

Nymph. Measures in total length 25 mm; abdomen 15 mm; hind femur 7 mm; width of head 7 mm, of abdomen 8 mm.

Body clean, smooth, depressed, very similar to Tramea, with rows of four to six black dots arranged transversely near the apex of abdominal segments 5–8, paired blotches at the middle of the sides of segment 7, at the lateral margins of segment 8, and near the middorsal line of

segment 9; black markings suffusing segment 10; a black mark on the middle of each of the inferior appendages; lateral setae 12 to 14; mentals about 15, the nine outer ones longer; teeth obliquely oval, as high as wide, spinulose at apex; tarsus with its second joint twice as long and its third, thrice as long as the first.

No dorsal hooks at all; lateral spines long, a little incurvate; those of the eighth segment reaching the level of the apical border of the ninth segment; those of the ninth segment twice as long as that segment, their apices reaching the level of the tips of the lateral appendages; superior appendage as long as or a little longer than the inferiors; laterals one fifth shorter.

The nymphs of this genus may be distinguished from those of Tramea by the greater length of the superior abdominal appendage, by the greater depth of the incisions between the teeth on the opposed margins of the lateral labial lobes, and by the brevity of the movable hook—hardly longer than the teeth, while in Tramea it is nearly as long as the setae.

Order NEUROPTERA

Ant lions, aphis lions, dobsons, etc.

Of this group as now delimited by most entomologists, a small proportion is aquatic, constituting one family (Sialidae) and part of another (Hemerobiidae). Members of the order agree in the possession of carnivorous habits and in their type of metamorphosis, and in little else. The families of Neuroptera occurring within the state of New York may be separated by the following table.

KEY TO THE FAMILIES OF NEUROPTERA

a Antennae enlarged toward the tip, club-shaped, or with a terminal knob (Larvae terrestrial: ant lions, etc.; the commoner ones make the well-known "pitfalls" in sand or dust in sequestered places. Pupa inclosed in cocoon of silk, hidden in the same places as those in which the larva lives) Myrmeleonidae

aa Antennae without terminal enlargement

b Fore legs fitted for seizing prey, stouter than the other legs; attached to the front end of an extremely long prothorax

(The larvae, so far as known, live parasitically in the nests of spiders and wasps, and transform to pupae in the same places within a cocoon of silk) ..... Mantispidae

bb Fore legs not thicker than other legs; not fitted for grasping; not attached at the front end of a very long prothorax

c Wings with few and simple veins, and covered with a whitish powder (Minute and rare insects; larvae, so far as known, arboreal; feeding on aphids; pupating in a double layered cocoon of silk) Coniopterygidae

cc Wings with many veins and not covered with whitish powder

d Wing veins all terminating at the distal border of the wing in a succession of symmetric forks, the ultimate forks often forming a peripheral zone around the distal margin of the wing

e Cross veins between the radius and its sector numerous (ten or more) (Green or yellowish insects: lace wing flies; larvae, aphis lions, arboreal; pupating in cocoon of silk, attached to the plants on which they have lived).....Chrysopidae

ee Cross veins between the radius and its sector few (two to six) Hemerobiidae

dd Wing veins meeting the outer wing margin in straight lines. Forks fewer, more remote from the margin and less symmetric.. Sialidae

The two families which contain our aquatic species will now be considered in detail. Their larvae have already been distinguished in the key to the orders of aquatic insect larvae.

Family SIALIDAE

Alder flies, fish flies, dobsons, etc.

This family comprises but few genera and species; but the large size and the enormous number of individuals of some of the species make them a well known part of the aquatic population. Few insects of inconspicuous coloration and secretive habits are so well known. Every species, in larval as well as adult stages, is attractive food for fishes, and many of them are among the insects most highly prized and most commonly used for bait.

The adult insects do not wander far from the borders of their native streams or ponds; they are generally found sitting closely on some support, with wings folded like a roof over the back. They fly but little.

The larvae are somewhat cylindric, with large heads and very large raptorial mandibles, and have on the sides of each of the first seven or eight abdominal segments a pair of long, conspicuous lateral filaments.

The eggs are deposited on any convenient support near the water, in clusters whose form varies with the genus, and to a less extent, with the species.

Our three genera may be distinguished as follows.

KEY TO GENERA OF SIALIDAE

Imagos

a Fourth segment of the tarsus bilobed; posterior branch of the radial sector forked. No ocelli..... Sialis

aa Fourth segment of the tarsus simple, cylindric; posterior branch of the radial sector simple. Three ocelli

b Hind angles of the head rounded; the median vein two branched; antennae with segments enlarged distally..... .....Chauliodes

bb Hind angles of the head bearing a sharp angulation or tooth; median vein three-branched; segments of the antennae cylindric

Corydalis

Larvae

a The last abdominal segment produced in a long, median, laterally fringed tail like process; a pair of lateral filaments on abdominal segments 1–7

Sialis

aa Last abdominal segment bifurcated, the fleshy forks each bearing a pair of hooks and a minute, external, lateral filament; conspicuous lateral filaments on abdominal segments 1–8

b Lateral filaments with no tuft of fine tracheal gills at their bases

Chauliodes

bb Lateral filaments each with a tuft of fine tracheal gills at its base

Corydalis

SIALIS

Alder fly[1]*: orl fly*

A single species of this genus is recorded from this state.

Sialis infumata Newman

Smoky orl fly

Plate 29, fig. 3

1838 Sialis infumata Newman, Ent. mag. 5:500
1853 Sialis infumata Walker, Cat. neur. ins. Brit. mus. 3:195
1861 Sialis infumata Hagen, Synopsis Neur. N. Am. p. 188
1863 Sialis infumata Hagen, Ent. soc. Phil. Proc. 2:180
1863 Sialis infumata Walsh, Ent. soc. Phil. Proc. 2:261–62 (figure of male genitalia)
1892 Sialis infumata Banks, Am. ent. soc. Trans. (listed)
1888 Sialis infumata Howard, Insect life, 1:99 (Sialis larvae in pools with Simulium)

This is a dusky brownish fly, often seen with wings closely folded sitting on sedge leaves near quiet waters. It may be taken with the fingers; but, if the fingers close too slowly, it will fall to the ground, kick vigorously several times to push itself into some crevice or tangle of stems and lie very quietly; then it will be difficult to find again. The collector may take advantage of this habit by bringing his opened cyanid bottle up to the insect from below.

This species is widely and generally distributed over the United States, and is often very abundant, specially westward. I have seen the grassy

1 So called in England because often found on alders overhanging tranquil streams.

shores of a pond at Galesburg Ill. black with these flies about the beginning of June.

Several adults were taken on both Little Clear and Big Clear creeks, during the latter half of June. Larvae were obtained in small numbers from Little Clear creek on the hatchery grounds. No attempt was made to rear them. I have reared the species in Ithaca N. Y. in 1897. Larvae obtained here agree entirely with others from Ithaca and from Galesburg Ill.

The larvae live in trashy places filled with aquatic plants in the borders of streams and ponds. They clamber through fallen vegetation with great agility, and push their way readily through sediment fallen on the bottom. In an aquarium, and probably outside, the abdomen maintains an undulating motion, the long tail being intermittently lashed up and down. This causes a swirl in the water, which is doubtless useful in bringing a fresh supply of water into contact with the lateral filaments.

The larvae, when fully grown, transform in moist soil at some little distance from the edge of the water. At a depth of several inches or a foot or more, depending on the character of the soil, an oval cell is formed in which the larva curls itself up, and without making a cocoon becomes a pupa. Two or three weeks after the making of the pupal cell the adult fly emerges.

Excellent available accounts of European species of Sialis are:

Pictet, F. J. Mémoire sur le genre Sialis Latreille, etc. Ann. sci. nat. (2) 1836. 5: 69–80, 1 colored pl. (life history)

Nunney, W. H. Development of the alder fly. Science gossip. n. s. 1895 2: 257–58.

Miall, L. C. The alder fly. Natural history of aquatic insects, p. 273–8, 1895.

Larva (Pl. 29, fig. 3) Measures in length 22 mm, including a tail 4 mm long; width 2.3 mm. Head and thorax of equal width, abdomen very slowly tapering.

Color yellowish, darker on the abdomen; a middorsal line of brown extending from the middle of the head to the base of the abdomen, interrupted on the middle of the prothorax; an arrow-shaped mark on the frons, and a brown line extending obliquely inward from the hind angles of the head. Sides of thorax mottled with yellow and brown. Abdomen brownish or purplish with paler sutures and a pair of submedian, dorsal ( )-marks on the middle abdominal segments.

Head depressed, subquadrangular, with rounded angles, and projecting mouth parts; prothorax subquadrangular, as large as the head, and about as large as the two succeeding segments of the thorax taken together.

Abdominal segments 4–7 of about equal length, 3, 2 and 1, successively, each a little shorter; segment 9 a little shorter than 8; 10 drawn out into the tapering, lashlike filament 4 mm long; the filament marked with black at two thirds its length and laterally fringed with yellowish

hairs; lateral filaments more or less distinctly 5-segmented, tapering, sparsely fringed with hairs, increasing in length posteriorly, on segment 1 as long as the width of that segment; on segment 7 twice as long as on 1.

Body smooth; legs smooth at bases, hairy toward the tip, yellow; tarsal claws unequal, tipped with black. As with other semi-burrowers and burrowers, the forelegs are closer together at base that are the legs of the other pairs.

Pupa. (Pl. 29, fig. 2.) Length (coiled) 9 mm; width of head 3.7 mm, of abdomen 4 mm.

Body clad with soft, fine hairs, specially on head and thorax; head and appendages pale yellow, varying with age. Thoracic dorsum yellowish with broad, brownish or purplish marks at sides and on front margins of segments; abdomen short, thick, accurate, with obtuse but prominent lateral margins, narrowed a little at both ends; no sharp angles or spines on any of the segments; apical segments mainly yellow; the others suffused more or less with brown or purple tending to be arranged in a pattern as follows: a middorsal, narrow line; a dorsolateral interrupted band; a lateral row of dots, three ventral rows each side of unequal marks, confluent in stripes or interrupted; sutures all darker. There is a transverse, anteapical, impressed line of brown on the middle abdominal segments.

CHAULIODES

Of the eight nominal North American species of this genus, but two are recorded from this state. These two and a third occur at Saranac Inn.

These insects are less secretive than those in other genera of the family. Imagos of some species of Chauliodes at least are abroad habitually during hours of sunshine, making short, fluttering flights from stem to stem. They rest most of the time: resting or flying, they are easily taken with a net.

The eggs are placed in somewhat regular rows on the surface of some leaf or other support; sometimes over water, but oftener at a short distance from it.

The larvae live in wet places at the edge of the water, or in water close to the surface, and are perhaps oftenest found clinging to the under side of floating logs or crawling beneath the loosened bark. They crawl rapidly and cling securely by means of the claws on the thoracic legs and on the bifurcated tenth abdominal segment. They swim but poorly by means of undulations of the abdomen and lashing of the lateral filaments.

The lateral filaments are less important respiratory organs than in Sialis. While they contain tracheae, they also contain a larger proportion of muscle and are covered by thicker integument. There are nine pairs of well developed spiracles, one pair in the sides of the prothorax at its hind margin, and one on each of the first eight abdominal

segments, situated just above the bases of the lateral filaments. The pair on the eighth segment is more or less elevated above the surface of the segment, being more or less extended in flexuous respiratory tubes. These tubes may reach a length exceeding that of the lateral filaments. They enable the larva to remain below while taking air at the surface of the water.

The genus is semiaquatic.

The full grown larva finds a place above the level of the water under a stone or log or layer of moss or in a rotten log and excavates a cell in moist soil or in rotten wood, in which without spinning a cocoon it enters on a pupal period of about two weeks' duration.

Three species of Chauliodes larvae were taken in the edges of Little Clear pond and creek. None of them were raised. One of them agrees with the larva figured as Ch. pectinicornis[1] by J. Bridgham in Dr Lintner's eighth report as entomologist of the state of New York (1893. pl. 1). Another is distinguished by its size: it is too large to be the larva of any known New York species save Ch. pectinicornis. The third one should belong to Ch. rastricornis,[2] and probably it does; for it agrees with the larva of that species as figured by Prof. Weed, and copied in the above mentioned report of Dr Lintner. Since no specific differences in habits were noted for these larvae save that the one referred to Ch. pectinicornis was less aquatic, and since they can not be referred to the species discussed below with positive certainty, the structural differences between them may as well be briefly indicated here.

a The spiracles of the eighth abdominal segment widely separated, their margins elevated but slightly above the level of the segment
Ch. pectinicornis, supposition

aa Spiracles of the eighth abdominal segment approximated and drawn out into a pair of long, flexuous, contractile respiratory tubes which surpass the tip of the abdomen

b Respiratory tubes conspicuously unequal in length; the 10th abdominal segment including its claws two and a half times the length of the ninth; the lateral filament of the 10th segment surpassing the tips of the claws by more than the length of the claws
Ch. serricornis, supposition

bb Respiratory tubes about equal in length; the 10th abdominal segment with its claws one and a half times the length of the ninth; the lateral filament of the 10th segment surpassing the tips of the claws by less than the length of the claws..... Ch. rastricornis, supposition

1 This, I take it, was a case of mistaken determination. The larva was not reared; it is too small to belong to pectinicornis; it is like larvae of Ch. serricornis, bred by Mr Henshaw and in the Museum of comparative zoology. I therefore refer it to that species.

2 Ohio agric. exp. sta. Tech. ser. Bul. 1889. 1:7-10, pl. 1, fig. 3.

Chauliodes rastricornis Rambur

1842 Ch. rastricornis Rambur, Ins. Neur. p. 444
1853 Ch. rastricornis Walker, Cat. neur. ins. Brit. mus. 3: 198
1861 Ch. rastricornis Hagen, Synopsis Neur. N. Am. p. 189
1863 Ch. rastricornis Hagen, Ent. soc. Phil. Proc. 2: 181
1863 Ch. rastricornis Walsh, Ent. soc. Phil. Proc. 2: 263-64 (larva described and distinguished from Corydalis larva)
1889 Ch. rastricornis Weed, Ohio agric. exp. sta. Tech. ser. Bul. 1: 7-10, pl. 1, fig. 3 (life history)
1892 Ch. rastricornis Banks, Am. ent. soc. Trans. 19: 357 (listed)
Ch. rastricornis Lintner, N. Y. state ent. 8th rep't. p. 158-59 (notes on distribution)

To the excellent account of this insect given by Professor Weed we have nothing to add save a few notes as to its occurrence at Saranac Inn. The imago was not observed at all outside our breeding cages. Larvae and pupae were obtained in several places about the shores of Little Clear pond.

June 14 Dr Felt and I, while looking over the ground preparatory to beginning regular operations, rowed into the little bay on the west side of Blueberry island in Little Clear pond and found the species in abundance. The bank was overhung with clumps of fragrant Labrador tea, and here and there lay a rotting hemlock log half in the water and half out, the exposed portion bearing an ornamental covering of matted moss and sundew plants. Our boat touched shore beside one of these logs; and there was a hole in the rotten wood, with an empty pupa skin hanging out of it. We followed this clue, and, examining the log, found the Chauliodes pupae. By pulling apart the crumbling fragments with our fingers, we in a very little while found in this and a few other logs near by, 25 pupae. One of these transformed on the way home, and the imago was lost; three were raised; a number were preserved for specimens, and the remainder died. On the 16th I returned to this place again, and found that by this time many had transformed. There were still plenty of pupae to be found, however, by diligent searching of the partly submerged and crumbling logs.

Chauliodes eggs, which I took to belong to this species, were not uncommonly found attached to the flat surface of some old, gray snag or board several feet above the surface of the water. They were more grayish in color than the eggs of Ch. serricornis, and were arranged in somewhat more regular V-shaped rows, and never more than one layer in depth. I saw a number of clusters about July 1 on the side of the boathouse facing the pond. These, as well as the clusters

found on snags about the lake shores, were very generally parasitized, by the very minute egg parasite, Trichogramma minutum Riley. The proportion of the eggs thus destroyed in a number of clusters collected in several places, was found by count to exceed 70%. As will be noted below, a great number of clusters of eggs of Ch. serricornis were hatched under observation. Among these not a single egg parasite was observed.

Chauliodes pectinicornis Linnaeus

Comb-horned fish fly

Plate 26, fig. 1

1763 Hemerobius pectinicornis Linnaeus, Amoen. acad. 6:412
1767 Hemerobius pectinicornis Linnaeus Syst. nat. Ed. 12, v. 1, pt 2, p. 911
1775 Hemerobius pectinicornis Fabricius, Syst. ent. p. 309,
1781 Semblis pectinicornis Fabricius, Spec. ins. 1:386
1787 Semblis pectinicornis Fabricius, Mant. ins. 1:244
1807 Chauliodes pectinicornis Latreille, Gen. crust. ins. 3:198
1862 Chauliodes pectinicornis Hagen, Synopsis Neur. N. Am. p. 189 (description of imago)
1863 Chauliodes pectinicornis Hagen, Ent. soc. Phil. Proc. 2:181 (mention)
1869 Chauliodes pectinicornis Walsh-Riley, Am. ent. 1:245 (characters of imago)
1869 Chauliodes pectinicornis Packard, Guide study ins. p. 607
1873 Chauliodes pectinicornis Hagen, Bost. soc. nat. hist. Proc. 15:29 (mention)
1874 Chauliodes pectinicornis Pettit, Can. ent. 6:45 (occurrence in Canada)
1877 Chauliodes pectinicornis Moody, Psyche. 2:52 (description (in part) and habits of larva)
1878 Chauliodes pectinicornis Riley, Can. ent. 11:97-98
1879 Chauliodes pectinicornis Riley, Am. ass'n adv. sci. Proc. p. 286-87 (eggs and characters of larvae)
1888 Chauliodes pectinicornis Comstock, Introd. ent. p. 220
1888 Chauliodes pectinicornis Packard, Ent. for beginners, p. 87 (mention)
1895 Chauliodes pectinicornis Comstock, Manual stud. ins. p. 178
Chauliodes pectinicornis Lintner, N. Y. state ent. 8th an. rep't. p. 155-59 (a full account with digest of preceding papers and original figure of imago (text fig. 15) and remarks as to its probable economic status)

A single female[1] specimen was bred from a pupa found in an old pine

1 This female was caged in a trap lantern (from which the cyanid was omitted) for a night and part of two days, in the hope of luring males, but without result.

stump in the edge of the water near the outlet of Little Clear pond. The pupal cell was located in red-rotten wood, fracturing, but not crumbling, and was about a foot above the level of the water. Soon after transformation the photograph reproduced in pl. 26, fig. 1 was taken. It shows beside the imago, a piece of the stump, the broken cell, and the pupal skin.

This is the largest of the ashen gray species of Chauliodes. It measures in length to tip of wings 54 mm. Expanse of wings 95 mm. It has sometimes been confused with the other common gray species Ch. rastricornis, but may readily be distinguished by the characters tabulated below.

CHARACTERS COMPARED	RASTRICORNIS	PECTINICORNIS
antennae of female	serrate	pectinate
embossed markings on head and prothorax	black on a paler ground	yellow on a black ground
prothorax	longer than wide	not longer than wide
radial sector	5–6 branched	7 branched
pale fuscous spots on fore wings	indistinct, isolated	meeting in narrow, transverse bands across the middle of the wing
base of the upper limb of first fork of radical sector, as far as the first cross vein in cell R_1	black	mostly white

Near the place where the insect was found in a stump the larvae referred to this species by supposition were taken: one on July 18, apparently fully grown, and two smaller ones June 30.

The full grown larva measured 55 mm in length; width of prothorax 5 mm; length of respiratory tubes on eighth abdominal segment only .7 mm. (Ch. serricornis larvae, length 36; of respiratory tubes 5; width of prothorax 3).

Color yellowish brown, darker on head and prothorax; margins of sclerites yellowish; clypeus yellow; labrum reddish brown. Legs yellowish, washed with brown exteriorly. A longitudinal mark of brown at

the base of each of the lateral filaments of the tenth abdominal segment on its inner side. Other characters as given in the table for larvae above.

Chauliodes serricornis Say

Saw-horned fish fly

Plate 27

1821 Chauliodes serricornis Say, Acad. nat. sci. Phil. Jour. v. 2, appendix p. 307
1839 Chauliodes serricornis Burmeister, Handb. ent. 2:949
1842 Neuromus maculatus Rambur, Ins. Neur. p. 442, pl. 10, fig. 2
1853 Neuromus maculatus Walker, Cat. Neur. ins. Brit. mus. 3:202
1861 Chauliodes maculatus Hagen, Synopsis Neur. N. Am. p. 190
1863 Chauliodes serricornis Walsh, (Corrects Hagen's names) Ent. soc. Phil. Proc. 2:262
1892 Chauliodes serricornis Banks, Am. ent. soc. 19:357 (listed)
1893 Chauliodes serricornis Lintner, N. Y. state ent. 8th an. rep't, p. 157 (notes on its occurrence in New York state, with original figure; larva described and figured as Ch. pectinicornis?)

This species was very common on Little Clear creek between the hatchery and the railroad. Half a dozen specimens could be picked from the sedges and flowering ferns in walking across this short open space any day in July. When resting on the under side of the leaves of the flowering fern, Osmunda regalis Linn., they were not easily disturbed; several were carried into the hatchery on a fern spray. A pair found *in copulo* was thus carried in and photographed (pl. 27); these pictures show the singular position assumed by the male in copulation. In this case, though not in any other of the many observed, the female had apparently already deposited a large number of eggs. Shortly after photographs *a* and *b* of the plate were taken the male departed, and the female resumed ovipositing. She added eggs at first in regular series, following the lines of the cluster already laid down; finally depositing a partial second layer in less regular order on the top of the first. While thus at work, the photograph reproduced as fig. *c* of the plate was taken.

A large number of egg clusters were seen, all of them on the under side of leaves of the above mentioned fern. In the cluster shown in these figures there were about 900 eggs. Some larger clusters were seen; many of them were smaller. These eggs hatched in 17 days. There appears to be great uniformity in incubation period with eggs of the same cluster. Numerous clusters were picked with the eggs all hatching at once, heads protruding, and jaws widely swung open, a most curious sight, a veritable *cheval de frise* of great rapacious mandibles.

The newly hatched larva of Ch. serricornis is 3 mm long, and has much the same aspect as older larvae of the genus have. The head

and mouth parts are relatively larger. The lateral filaments bear two spinules at their apex, the posterior one minute. Each filament shows a central tracheal branch, without distinguishable tracheoles and with a rough prickly surface which is certainly not suggestive of a respiratory organ. The circulation of the blood, easily seen in other parts of the body, I could not observe in these at all.

Respiratory tubes from the spiracles of the eighth abdominal segment, wide apart, short, not half as long as the segment. The lateral filaments of the tenth abdominal segment are short, bearing three setae, of which the two exterior are longer than the filament itself: filament not surpassing the tips of the claws. The two longitudinal tracheal trunks within the body terminate in the tubes springing from the spiracles of the eighth abdominal segment, but they are much stouter anteriorly where passing the other spiracles, and they bend distinctly outward to meet the spiracles of the prothorax.

Antennae three-jointed, the second joint bearing at its distal end exteriorly a pair of spinules close beside the base of the terminal joint.

The brevity of the respiratory tubules on the eighth abdominal segment is doubtless ancestral; and the spinules on the lateral filaments may mean that these filaments are but modified larval setigerous tubercles. The function of the filaments is largely locomotor; they are used as fins in swimming. But they are also "outriggers," if we may so speak, serving to maintain the proper position of the long abdomen while crawling about over submerged logs.

Ch. serricornis was first taken June 20, and was quite common for a month thereafter. The pupa was searched for, but not found.

Corydalis

Our sole species, C. cornuta Linn. is too well known to need another description. It will be recognized by the characters stated in the keys, and by Dr Lintner's figures, reproduced herewith as Plate 28.

Family HEMEROBIIDAE

This family has received little attention from entomologists in America. I do not now recall a single American species whose life history is known in full. A single species supposed to be aquatic has been twice reported from the United States—once from New York state. It is gratifying therefore to be able to add another genus, Climacia, to the list of aquatic genera, and to make a slight contribution to the knowledge of its habits and life history.

KEY TO GENERA OF HEMEROBIIDAE[1]

a Branches of the radical sector arising (i. e. separating from vein R_1) by a common stalk (fig. 32)

b Humeral cross vein recurrent, and bearing several branches on its outer side ..... Polystoechotes

bb Humeral cross vein unbranched and not recurrent

c The median vein repeatedly forked; some of the branches of vein Cu_1 forked ..... Sisyra

cc The median vein but once forked; the branches on vein Cu_1 simple ..... Climacia

aa Branches of the radial sector arising separately from vein R_1

d Humeral cross vein recurrent and bearing several branches on its outer side ..... Hemerobius

dd Humeral cross vein unbranched and not recurrent ..... Micromus

The typical genus, Hemerobius, includes the majority of the described species of the family. Its larvae are commonly arboreal, and feed on aphids, small moth larvae, etc. They commonly spin their loose cocoons of silk in crevices of the bark and there undergo their transformations.

Of the American genus Polystoechotes, which contains our largest species, the life history has not been recorded. Hagen, characterizing the genus in 1861 (*Synopsis Neuroptera of North America*), wrote "Larvae perhaps aquatic"; and this opinion has been handed down to the present time. I obtained some of the eggs in July by confining some of the females of Polystoechotes in a pasteboard box. The eggs were dropped at random on the bottom of the box, where they rolled loosely about. They were chalky white in color, oblong oval in outline, with surface minutely granular. Some were dropped on water in a glass, where they floated high and dry; and the next day were overgrown with molds. The others were left in the box, and the box closed that more eggs might be obtained: instead, the females ate the eggs already laid, and then began to devour one another. Thus I lost an excellent opportunity for studying the earlier part of the life history of this interesting insect. The character of the eggs, and the haunts of the females lead me to suppose rather that the larva is terrestrial or arboreal, as in Hemerobius.

Polystoechotes punctatus (pl. 26, fig. 2) Fabr. was not uncommon during the month of July. It was taken a few times in our trap lanterns; but, for some, to me unknown reason, was found in numbers only in the Saranac Inn railway station. At the windows of the depot one might expect to gather with little effort a dozen or more specimens in an evening.

1 Three North American genera remain as yet unreported from New York state: Dilar, with a single species, distinguished from the remainder of the family by the possession of ocelli; Psectra, with a single species, distinguished by its having normally but two wings; and Berotha, with three species, distinguished by having the apex of the wing very acute, and a notch or excision in the outer wing margin.

Clearly, Dr Lintner found this species in far greater abundance at Long lake, Hamilton co. N. Y. in August 1885[1]; for he wrote of it, "Hundreds could be seen resting on the parlor walls."

But two hemerobian genera have been accounted aquatic hitherto. These are Osmylus, a European genus, whose life history has been fully made known by Hagen and Brauer, and Sisyra, whose larvae, common in fresh-water sponges in Germany and in England, seem to have been determined by exclusion; at least I have been unable to find any account of the rearing of the larvae or any description of the pupae or the cocoons. I reared many of the larvae at Saranac Inn during the past season; and bred also the American genus Climacia, of whose habits nothing seems to have been known hitherto. It also is aquatic, and, like Sisyra, lives on fresh-water sponges.

Larvae and pupae of these two genera may be separated as follows.

Larvae

a Setae on the dorsum of the thorax pedunculate (i. e. the setigerous tubercles elevated considerably above the level of the integument).... Climacia

aa Thoracic setae sessile..... Sisyra

Pupae

a Tips of the fore tarsi extending posteriorly beyond the apices of the maxillary palpi; the fifth segment of the latter less than twice the width of the fourth. Outer covering of pupal case of open regular hexagonal mesh Climacia

aa Fore tarsi and palpi with apices about on a level; fifth segment of the maxillary more than twice the width of the fourth. Outer covering of pupal case closewoven ..... Sisyra

Sisyra

1771 DeGeer, Mem. pour servir á l'histoire nat. ins. v. 2, pt 2. German translation 1779: index, "Die schwarze haarichte Hemerobius, eine neue gattung," v. 2, pt 2, p. 71, no. 3. "Die schwarze, haarichte Hemerobius, mit hellbraunen flügeln und braungelblichen füszen." (A good detailed description of the species afterward named Hemerobius fuscatus by Fabricius, and made the type of the new genus Sisyra by Burmeister. Pl. 22, fig. 8 nat. size, fig. 9 more enlarged imago, fig. 10 head still more enlarged, fig. 11 fore wing)

1835 Stephens, Section C of genus Hemerobius. Illus. Brit. ent. 6: 114

1839 Sisyra Burmeister, Handb. ent. v. 2, pt 2, p. 975 (original description of the genus)

1840 Sisyra Wesmael, Acad. Brux. Bul. 8: 4 of reprint, which only I have seen. The article is "Notice sur les hemerobides de Belgique." 19 p. 4 pl.

1 "Collections in the Adirondack region in 1885," in his fifth report on the Injurious and other insects of the state of New York. Albany 1889. p. 286.

1842 Sisyra Rambur, Ins. Neur. p. 414–15
1851 Sisyra Hagen, Stett. ent. zeit. 12: 185–86 (bibliography)
1857 Sisyra Brauer, Fauna Austriaca; Neur. p. 55 and p. 22 of introduction
1858 Sisyra Hagen, Ent. annual p. 25
1861 Sisyra Hagen, Synopsis Neur. N. Am. p. 197
1868 Sisyra Brauer, Verh. k. k. zool.-bot. ges. in Wien. p. 398
1868 Sisyra McLachlan, Ent. soc. Lond. Trans. p. 166–67 (the fullest characterization of the genus)

Larva

1839 Westwood, "an anomalous insect found in the Spongilla fluviatilis" Mag. nat. hist. (2) 3:200; An. sci. nat. (2) 11:380
1840 Westwood, Introd. modern classification of ins. 2:586 (notes on the larvae, with some bad guesses as to their place in the system)
1840 Hogg. "Observations on Spongilla fluviatilis," Linn. soc. Lond. Trans. 18:390–92; Isis for 1843, review, p. 466
1842 Westwood. "Descriptions of some insects which inhabit the tissues of Spongilla fluviatilis," Ent. soc. Lond. Trans. 3:105–8, fig. (Names the larvae Branchiostoma spongillae)
1842 Erichson. Wiegm. arch. f. naturg. p. 91
1842 Rambur in Ins. Neur. p. 415, says the larva of Sisyra is aquatic
1844 Grube. Beschreibung einer auffallenden, an süsswasserschwämmen lebenden larve, Wiegm. arch. f. naturg. 11:331–37, fig. (refers the larvae to Sisyra)
1847 Haliday. On the Branchiostoma spongillae, and on Coniopteryx, Ent. soc. Lond. Trans. 5: Proc. 31–32
1848 Westwood. The Spongilla insect, Gardener's chronicle, p. 557
1851 Hagen. "Uebersicht der neueren litteratur betreffend der Neuroptera, Linne." Stett. ent. zeit. 12:185–86 (under Hemerobius [Sisyra] fuscatus Fabr., says that the larva is not known, but that it is probably the Branchiostoma spongillae of Westwood, since the adults are very abundant all through the summer, and are found only near water)
1855 Brauer. "Beiträge zur kenntniss des inneren baues und der verwandlung der neuropteren," Schriften des zool.-bot. vereins in Wien, p. 1–26, 5 pl. p. 3, "Die fragliche Sisyra-larve"
1858 Hagen. "Synopsis of the British planipennes," Ent. an. p. 25 (under Sisyra, says: "Larva lives in the water (Branchiostoma spongillae Westwood: cocoon?")
1866 Hagen. "Hemerobidarum synopsis synonymica." Stett. ent. zeit. 27: 369–462 (on p. 388, says that the Branchiostoma is the larva of Sisyra fuscata Fabr.)

Subsequent papers repeat this statement, but I have been unable to find any account of the life history of the genus, or any description of the pupa or cocoon.

Anyone who will take the trouble to look through the published records of the larva of this dusky little fly will discover that it has had

an interesting history, and has occupied a unique place in our entomologic literature. Unlike the larva of the beetle, Psephenus, or that of the syrphus fly, Microdon, or the larval case of the caddis fly Helicopsyche, or the nymph of the May fly, Prosopistoma, all of which were for a time mistaken for mollusks, the Sisyra larva, was clearly an insect, but not referable by its discoverers to any definite place in the insect series. James Hogg first found it while studying fresh-water sponges, and J. O. Westwood brought it to the notice of the public. A discussion was then raging in the learned societies of the old world as to whether sponges belong to the plant or to the animal kingdom, and the Sisyra larva was dragged, an innocent victim, into this controversy. Dujardin, maintaining that sponges are animals, told the French academy that he found in the sponge body numerous fine filaments that moved to and fro. James Hogg, on the other hand, believing that sponges are plants, maintained before the Linnaean society of London that the filaments seen by Dujardin were the setae on the back of these larvae, which had crawled, as is their wont, into the sponge through the open osteoles.

The larva possessed two structures, also, so unique in character that interest in them has survived the sponge controversy, and on account of which the original figures of Westwood and Grube are handed down in textbooks of the present day. These peculiar parts are 1) paired, jointed appendages beneath the abdominal segments, and 2) long, decurved, piercing mouth parts, of a unique suctorial type.

Notwithstanding the interest attaching to this larva, it seems not to have been reared. That it belonged to Sisyra was, I take it, a logical deduction. The brief quotations which I have inserted in the above bibliography will serve to show how the conviction grew. The small size of the larva, and its certain Hemerobian affinities (the larva of other genera being known) left no doubt that it was Sisyra. I was unwilling to believe that it had not been reared till after consulting all the literature in which I could find any mention of it, and examining at Cambridge Dr Hagen's manuscript drawings illustrating hemerobian life histories and finding among them a larva well drawn, but no pupa or cocoon.

There are several European species of Sisyra: there is one North American species, S. vicaria Walker, described from Georgia, and afterward reported from New York.[1] The species I found at Saranac Inn is very close to the typical Sisyra fuscata Fabr. It differs

1 Banks. Am. ent. soc. Trans. Possibly not vicaria.

from S. vicaria in being much larger, according to the measurements given in the extremely brief and uncritical published descriptions of that species. There is a specimen from Illinois in the Museum of comparative zoology, and I collected many specimens of both larvae and adults at Lake Forest Ill. in June 1899. I did not at that time rear the species, however. I describe it below as Sisyra umbrata n. sp.

In passing, I should call attention to an error almost uniformly committed in the characterizing of this genus: there is said to be no cross vein in the basal part of the subcostal space. As a matter of fact, that cross vein is almost always present, though it is sometimes not very distinct. I have examined specimens of three European species in the Museum of comparative zoology, among them a large series of specimens of the typical S. fuscata, as well as hundreds of specimens of the species described below, and have not noted the absence of this cross vein in a single case.

Sisyra umbrata sp. nov.

Pl. 12, fig. 6, 7 and 33, 34, 36 text figures

Length to tip of wings, male 6 mm; female 8 mm; expanse of wings, male 12 mm, female 13 mm.

Color nearly uniform blackish brown. There is a faint wash of rufous on the face, the legs and the apex of the abdomen are dirty yellowish.

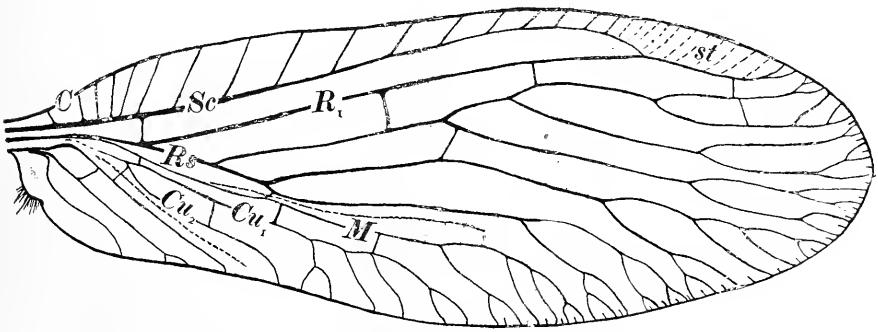

Fig. 33 Fore wing of Sisyra umbrata

Lake Forest Ill. June 1899; Saranac Inn N. Y. June 28 to July 16, 1900; abundant.

This is a stouter, larger, blacker, more hairy species than S. fuscata. The second segment of the antennae is nearly as large as the third and fourth together, and the third is little more than half the size of the fourth; in S. fuscata the second, third and fourth antennal segments are subequal, and the third is not distinctly smaller than the fourth. In

S. umbrata the last joint of both palpi is distinctly pediform (fig. 34, 36); I have not been able to examine the palpi with any degree of satisfaction in any specimen of S. fuscata, but according to Wesmael's figure[1] the terminal segment should be simply conic.

During the first week of our stay at Saranac Inn we scraped the surface water supply trough in the hatchery, and in the scrapings found about 100 small fresh-water sponges. A few of the larvae of this species were found on the sponges. Shortly the cocoons began to appear on the sides of the supply trough, and in such numbers that it was evident that the larvae were coming in from the pipes. The cocoons were located, some inside the supply troughs on the smooth, tarred, vertical sides just above the water, some on the upper edges, some on the sides and edges of the hatching troughs below, but mostly on the outside of the supply troughs and in the angles which they make with the hatching troughs, or in the thread grooves at the base of the faucets. Each larva spins over itself, a hemispheric cover of close woven silk (pl. 12, fig. 11), attached by its edges to the supporting surface, and a complete inner cocoon of considerably smaller size, likewise close woven.

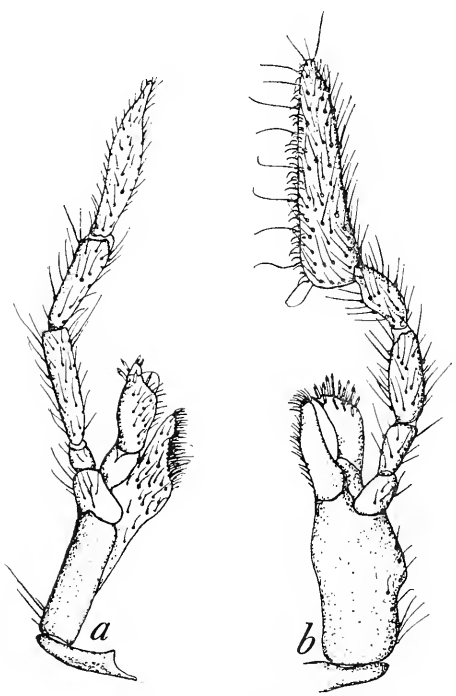

Fig. 34 Maxillae:
a of Climacia dictyona Ndm.
b of Sisyra umbrata Ndm.

Larvae of this species taken from unfinished cocoons and placed in a vial spun new cocoons in the corners of it under observation. It was interesting to watch them weaving back and forth their anal spinnerets, as the threads were laid down.

Two larvae of this species, taken just as they were leaving the water June 21 and placed in a vial plugged with cotton, spent at least 12 hours in spinning their cover and cocoon, and remained inactive larvae 24 hours longer. Then they transformed to pupae, which remained suffi-

1 Acad. Brux. Bul. 1840. v. 7, fig. 3 of plate.

ciently active thereafter to kick vigorously whenever the vial was moved, The imagos emerged July 2, 11 days after leaving the water. The pupa makes its way through the side of the cocoon, and the empty pupal skin is left sticking in the hole when the imago flies away.

In the supply trough in the hatchery fresh-water sponges of small size were easy to find, and I saw the Sisyra larvae clinging to them, crawling over them, and apparently piercing them with their long, sharp decurved jaws. I also observed this later on a sponge-covered log in Little Clear pond. The larva clings closely to the sponge surface, lies in the hollows of it, or, sometimes, descends bodily into an open osteole. The numerous spines on its back usually carry a load of debris beneath which its form is well concealed. It can readily be driven about over the sponge surface, but will hardly be induced to take a step away from it on the bare wood.

The respiratory filaments are jointed and folded beneath the abdomen. They are moved intermittently in a rapid shuttle-like vibration.

Imagos on emergence seemed by preference to fly at once to the hatchery ceiling. They congregated on the best lighted portions of it. I stood in one spot on my work table and collected from the part of the ceiling within reach hundreds of specimens at a time. Nothing was easier. They would jump directly into an unstoppered bottle held close below them. Their flight to the ceiling on emergence suggests a probable reason why I was able to see so few specimens out of doors. There they probably fly directly to the tree tops—the home of their nonaquatic kin. A few specimens were taken at a trap lantern placed near the outlet of Little Clear pond. I caught one or two specimens close above the water while sweeping aquatic vegetation in Little Clear creek. These may have been females ovipositing, but I did not find their eggs. Neither did I get them, though I several times inclosed females in cages supplied with aquatic plants and with sponge-bearing pieces of wood.

A student in my laboratory at Lake Forest college is working on the anatomy and metamorphosis of this species. I prefer to leave the farther characterization of the several stages to the paper which will result from that work.

CLIMACIA

1869 McLachlan. "New species of Hemerobina, with synonymic notes", Ent. month. mag. 1:27. The genus is carefully characterized, and is correctly allied with Sisyra, from which it is distinguished by the following characters, the first of which will not hold:

1 A single basal cross vein in the subcostal space
2 Two well defined series of gradate veins
3 Prothorax elongate
4 Face long and triangular
?5 Two curious setiform organs, apparently attached to the maxillae

That these last, whatever they may have been, were extraneous, is evident from an examination of the maxillae of fresh or alcoholic specimens (fig. 34). McLachlan had for examination only a few dried specimens. "Larva probably aquatic".

The single species of this genus hitherto known, C. areolaris Hagen has been reported only from the southern states. There are numerous specimens of it, however, in the Museum of comparative zoology from Waltham and Cambridge Mass., as well as a number from Florida. The species found at Saranac Inn and described below differs from areolaris in being of darker color on the wings (black, where areolaris is but brown), of larger size (females of areolaris do not exceed the measurements given by Hagen[1]), and in having the vein Cu_1 seven-branched (it is six-branched in areolaris).

Climacia dictyona sp. nov.

Pl. 12, fig. 1, 2 and 34-36 text figures

Imago. Length to tip of wings, male 6 mm, female 8 mm; expanse of wings, male 11 mm, female 13 mm; length of antennae 5 mm.

Face yellow; eyes blackish; top of head rufous; thorax black; legs clear yellow beyond the coxae, excepting the extreme tips of the tarsi.

Wings smoky brown, varied with yellow and black. Pterostigma yellow, with a black mark each side; the proximal one curving

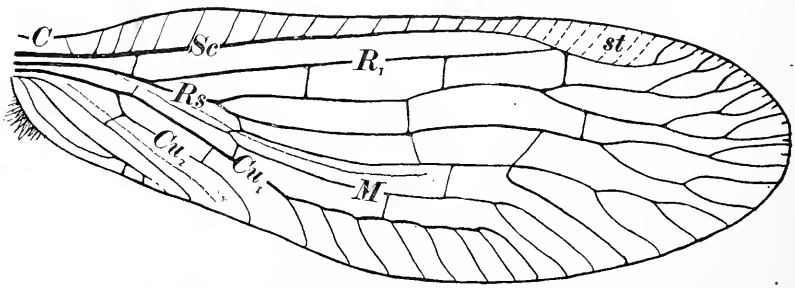

Fig. 35 Fore wing of Climacia dictyona Ndm

posteriorly and then anteriorly to the base of the wing, leaving the greater part of the costal area yellow. A triangular yellow spot on the fork of the median vein, its apex directed toward but hardly reaching the hind margin of the wing; from its proximal side a less distinct yellowish streak extends to the base of the wing on the hind margin. Veins black except where crossing the yellow areas. In the wider spaces there are distinct fuscous, longitudinal streaks midway between the veins.

Abdomen brownish, paler apically.

Saranac Inn N. Y. Common. June 18 to July 1, and Aug. 10 to 20.

Figures: wing, fig. 35; maxilla, fig. 34; labium, fig. 36.

1 Synopsis Neur. N. Am. p. 199.

Larva. Length 5.5 mm; greatest breadth of body exclusive of spines 1 mm.

Color yellowish to greenish, varying with the color of the sponge, obscurely marked with brown; a middorsal incomplete stripe, darkest on the thorax (where also is a lateral one each side), divided and more interrupted on the abdomen.

Antennae setaceous, very sharp pointed, a very little longer than the piercing mouth parts, 15-jointed, the two basal joints turgid, meeting at an angle, the other segments narrowly cylindric.

Mouth parts adapted for piercing and sucking the sponge substance; labrum and labium rudimentary; mandibles and maxillae developed as long, channeled, decurved stylets, which may be applied in pairs, or all four together.[1]

Body with two rows each side of dorsum of mostly trifurcate, trisetigerous tubercles; a pair of simple, unisetigerous tubercles on the ventral side of the eighth abdominal segment. 10th abdominal segment not setigerous; extensile, bearing the spinneret.

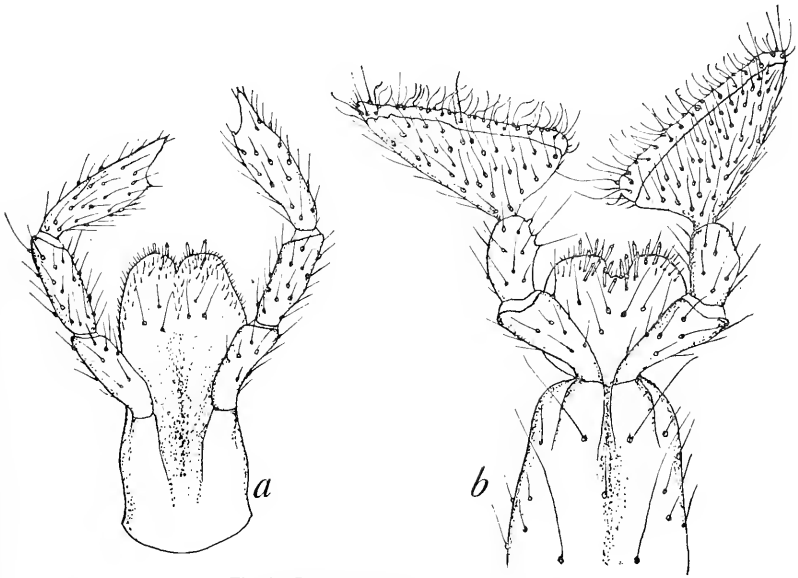

Fig. 36 Labia
a of Climacia dictyona Ndm
b of Sisyra umbrata Ndm

Very soon after my arrival at Saranac Inn, M. A. Roberts, a careful and observant employee of the Adirondack hatchery, called my attention to some minute, hemispheric, silken pupa cases, attached to the sides of the supply troughs in the hatchery building. There was an outer covering of coarse silk (pl. 12 fig. 4, 5) woven in hexagonal meshes, like bobbinet;

1 These are cast off, and the normal biting mouth parts developed during metamorphosis.

and there was an inner cocoon of finer threads closely woven. An examination of the contained pupa showed it to be a hemerobian. From some pupa cases stripped from the trough and placed in a vial plugged with cotton, I first bred on June 18 the species described above as Climacia dictyona n. sp. The same day I found my first specimen at large in one of the hatchery windows.

During the remainder of June the imagos of this species were fairly common. Then they disappeared, to reappear in some numbers about the middle of August. Whether this means another distinct brood I can not say, with certainty.

The larvae and pupae are very similar in form and in habits to those of Sisyra, described above. The cocoons are similarly located, and are often intermixed with those of Sisyra, but are much more beautifully and skilfully wrought. The imagos were taken a few times at trap lanterns, and in sweeping of aquatic vegetation, but the hatchery ceiling was the best collecting ground. The eggs were not found. The larvae, as in Sisyra, live on fresh-water sponges.

I could find none of these sponges in condition fit for determination; up to the time of leaving Saranac Inn no gemmules were developed on them. The commoner species, and the one on which larvae of both Sisyra and Climacia were observed, was probably Spongilla fragilis Leidy; for they appeared to be quite the same species as that on which I found Sisyra larvae at Lake Forest, and that was certainly S. fragilis. It was not without interest that I noted a striking difference in the behavior of this sponge in the two localities. At Lake Forest it grows on logs in a very shallow, exposed pond, which generally dries up about midsummer, leaving the logs exposed, usually to remain so for several months. There, gemmules were fully formed before the first of July. In the cool, deep, permanent water of Little Clear pond, however, where sponges were likewise abundant on the logs but not subject to exposure and evaporation, I could find no gemmules at all up to the time of my departure, August 20.

I would suggest that as a common name for the insects of these two genera, spongilla flies, or sponge flies, would not be inappropriate.

Order TRICHOPTERA

Caddis flies

BY CORNELIUS BETTEN

Insects of this order were found to be very abundant at Saranac Inn. Larvae and pupae were very common in Little Clear creek and along the edges of the lakes and ponds of the vicinity, while adults were taken in great numbers by the trap lanterns. Throughout the period of work, swarms of adults, mainly of three species, settled on the hatchery windows, having doubtless transformed in the fish troughs. While the material was therefore abundant, only four species were successfully reared. Of many species the time of transformation did not fall within the period of the work, and consequently a full life history could not be recorded.

The larvae of these insects, as is well known, build for themselves cases differing greatly in manner and material of construction. Several species of larvae were reared from the egg, and the larvae were observed to begin making their cases almost immediately after hatching. Before building their cases the young larvae are doubtless at the mercy of many enemies. Hydras were seen killing many of them in rapid succession but were unable to use them as food because of their size. The characteristic forms of the cases may be recognized almost from the beginning. The cases are enlarged as the growth of the insect demands. The food of the larvae is doubtless largely vegetable. Several species were observed feeding on stonewort, Nitella, and river weed, Potamogeton, which flourished in the creek. Some species are however known to be carnivorous in their habits.

Well protected by its case, the body of the caddis fly larva needs no hard covering of chitin. The head and the thorax, with the three pairs of legs, protrude from the case when the larva is moving about or feeding, and these parts are protected somewhat more than the other parts. The legs terminate in one-jointed tarsi, each of which has a single claw. A spur is very prominent at the base of each hook. The abdomen has nine well defined segments and an anal appendage terminated by a pair of hooks pointing outward. These hooks can be fastened into the sides of the case and thus prevent the forcible eviction of the larva. The dorsal side of the first segment is marked by a large protractile tubercle. Two smaller tubercles are located on the ventral side of the same segment. These tubercles are supposed to serve the larva as a means of maintaining its position in its case. This view is supported by the fact that a species of Hydropsychidae reared at Saranac Inn constructed no larval

case and had no tubercles on the abdomen. Numerous filaments on the abdomen serve as respiratory organs, obtaining oxygen from the water which is kept circulating through the case by the undulatory motion of the body.

When the time for transformation approaches, the larva closes the opening of its case, sometimes with the same material as that used in the case itself, but frequently with other things. Sometimes only a web of silk is spun across the opening, and in every case sufficient space is left for the circulation of the water. During the pupal period the cases are generally fastened to submerged sticks, stones or other supports. In size the pupa does not differ greatly from the larva. The eyes have become far more prominent. Wings and antennae appear and are folded backward and downward under the body. The legs and palpi are also folded beneath the body. In place of prolegs and hooks, two long tube-like processes (fig. 38) terminate the body. The pupa holds its position by means of hooks on the dorsal side. Generally there are hooks pointing backward at the anterior edge of several segments, while at the posterior edge of one or two segments is a pair of plates bearing spikes which point forward. The respiratory filaments remain, and breathing is doubtless accomplished by the same method as in the larval stage. When the time of transformation arrives, the pupa leaves its case, climbs up some support, casts its skin and emerges as an adult insect. Some species emerge directly from the surface of the water.

So far as observed, the adult caddis flies do not feed. They spend their lives near the place of emergence, most of them flying but little, at least during the day, but some species may be seen swarming just over the surface of the water. The large number taken by the trap lantern is evidence of the nocturnal habits of the adults. The laying of the eggs was not observed but must of course take place in or directly above the water. Many clusters of eggs were found under the bark of submerged trees, which would lead to the conclusion that in some cases the female insect goes under water to deposit the eggs. The circular cluster of greenish eggs shown in plate 33, figure 4 was found suspended on a submerged twig under a log floating in deep water. The number of eggs in this cluster was estimated at 450.

In the description of species given below, there was no opportunity for comparison with other work of the same kind. In fact, no descriptions of the immature stages of the American species of Trichoptera has heretofore been published, except the paper of Miss Cora Clarke[1] which

[1] Clarke, Cora H. Caddice worms of Stony brook. Psyche. 1891. p. 153.

deals chiefly with the cases and the habits of a few species. Two of those described by her seem to correspond with two described below, viz, Molanna cinerea Hag. and Polycentropus lucidus Hag. There have subsequently come to hand the very valuable papers of Prof. Klapálek[1] in which the cases, larvae and pupae of 53 European species are described. It is from these papers and from that of Dr Struck[2] that the following table for the determination, by families, of caddis fly larvae has been compiled. The undetermined species herein described have been arranged according to this table. I regret exceedingly that a closer determination has been impossible. The first three species discussed below were reared and subsequently determined from the adults. The fourth in the list was also reared. Its adult was sent to MacLachlan but no report of its identification has yet been received. I have found that adult characteristics are sufficiently evident in the pupae to admit of determination, to families, by the use of Banks'[3] table for adults.

For the identification of the adults herein listed, I am largely indebted to Mr Nathan Banks of Washington D. C. The drawings of the cases, larvae, pupae and adults are all by Mrs J. H. Comstock of Cornell university. I am indebted most of all to Dr J. G. Needham, under whose direction this work has been done.

KEY TO FAMILIES OF CADDIS FLY LARVAE

a Larva larviform, i. e. with head bent downward at an angle with the body, tubercles generally present on the basal abdominal segment, gill filaments, when present, simple (except in some Limnophilidae), lateral fringe generally present.

b Hind legs not more than twice as long as the first pair.

c Head longitudinally elliptic, at slight angle with the body, pronotum only chitinized, abdominal constrictions deep, third pair of legs slightly longer than the first. *Cases* of vegetable matter laid longitudinally and forming a spiral, widening at the anterior end...Phryganeidae

cc Head oval to round, pronotum chitinized, mesonotum often, metanotum seldom chitinized, abdominal constrictions slight.

d Lateral fringe well developed; cases various.....Limnophilidae

dd Lateral fringe slightly developed, cylindric case of sand or small stones.....Sericostomatidae

e Three tubercles

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[1] Klapálek Fr. Metamorphose der Trichopteren, Archiv der Naturwissenschaftl. Landdurchforschung von Böhmen 6, Band No. 5 and Band 7, No. 6.

[2] Struck, R. Neue und Alte Trichopteren-Larven-gehäuse. Illus. Zeits. Ent. Bd 4. No. 8, 10, 13, 17, 19, 21, 22.

[3] Banks, Nathan. A synopsis, catalogue, and bibliography of the Neuropteroid insects of temperate North America. Am. ent. soc. Trans. 1892. 19:338.

f Tubercles low and broad, pronotum quadrilateral, claws with two basal hooks.....Sericostoma, Oecismus, Notidobia

ff Tubercles conical, pronotum transversely elliptical
Goëra, Silo, Lithax

ee No dorsal tubercle

f No lateral tubercles
Brachycentrus, Oligopletrum, Micrasema

ff Lateral tubercles present
Crunoecia, Lepidostoma, Lasiocephala

bb Hind legs more than twice as long as the first pair, abdominal constrictions slight, cylindric case of sand and small stones.....Leptoceridae

aa Larva campodeiform, i. e. with head in line with the main axis of the body, tubercles and lateral fringe wanting, gill filaments, when present, branched

b Abdomen little, if any, thicker than the thorax

c Third pair of legs about the same length as first pair, no portable larval case.....Hydropsychidae

cc Third pair of legs a little longer than the first. No larval cases
Rhyacophilidae

bb Abdomen much thicker than the thorax: case kidney shaped, of small stones, or flat and parchment-like .....Hydroptilidae

SPECIES REARED AT SARANAC INN

Molanna cinerea Hagen

Plate 13, figures 1–6

1861 Molanna cinerea Hagen, Synopsis Neur. N. Am. p. 276

1892 Molanna cinerea Banks, Am. ent. soc. Trans. 19: 366 (listed)

Habitat. Larvae and pupae were found in great abundance on sand bottoms with little or no vegetation. Adults rest on vegetation or other support near the place of emergence, their appearance, specially their position (pl. 13, fig. 5), with antennae laid flat on support, wings and abdomen elevated, causing them to be easily mistaken for small snags.

Occurrence. Abundant throughout the period of work.

Case. (Pl. 13, fig. 6) Flat case of sand and very fine stones. Rounded at both ends. Forward end extended on dorsal side, forming a protection to the larva even when reaching out of its case. Length 20 mm. Greatest width of 10 mm near the forward end.

Larva. (Pl. 13, fig. 1–2) Length 12 mm. Width 2 mm. The head, prothorax, and mesothorax are light brown or yellowish. Metathorax and abdomen are light green. A black Y-shaped line extends over the head and prothorax, the arms of the Y running from the corners of the mouth and joining at the rear of the head. The pedicel of the Y extends over the

prothorax. Another black line incircles the head and prothorax, running through the base of the Y, passing obliquely downward to the gula which is of the same color. The mesothoracic shield is spotted with black and brown. The legs are light brown, the coxa, trochanter, and proximal part of the femur being margined with black. The first and second pairs of legs each have one prominent spur on the tibia. The third pair of legs is more slender and hairy than the others, and the tarsi are terminated by small, feathery brushes instead of hooks. Two rows of respiratory filaments occur on the dorsal, and two on the ventral side. The number of filaments issuing at the same spot on the dorsal side is 0, 4, 4, 4, 3, 2, 2, 0, 0, and on the ventral side 0, 3, 3, 3, 2, 2, 0, 0, 0, the figures representing the segments in order. These filaments are placed at the anterior margins of the segments. The hooks terminating the body are supported on two-jointed prolegs.

Pupa. (Pl. 13, fig. 3) Length 12 mm. Width 2 mm. Antennae 10 mm. Wings 7 mm. Head and thorax white; abdomen pink or green. Two black lines run the length of the body both above and beneath. Respiratory filaments persist on both dorsal and ventral sides. The lateral fringe which forms a loop under the eighth segment is composed of soft black hairs. The spurs on the tibiae, which appear as feathery brushes, number 2, 4, 4 on the first, second and third pairs of legs respectively. Hooks pointing backward occur in two rows on the dorsal side of the third, fourth, fifth and sixth segments at the anterior edge of the segments. Two plates with spikes pointing forward are at the posterior edge of the fifth segment.

Polycentropus lucidus Hag.?

Plate 13, figures 7–11

Habitat. Larvae and pupae were found in sandy bottoms with little or no vegetation. Adults were commonly found resting on vegetation in the creek and on the side of the hatchery near the stream.

Occurrence. Abundant throughout the period of work.

Case. (Pl. 13, fig. 10) Very soft tubular case of fine sand. It is frequently branched and where the insect lies has two distinct layers. The tube is much longer than the larva and is not portable. The position of the larva or pupa is readily recognized. They lie in a part of the case twice the diameter of the rest of the tube.

Larva. (Pl. 13, fig. 7) Length 14 mm. Width 2 mm. Head yellow; prothorax yellow with black line incircling its rear margin. The

remainder of the body white; legs yellow with black line extending backward from the coxa of the second and third pairs of legs over the mesothorax and metathorax respectively. No respiratory filaments, tubercles or lateral fringe are present. The terminal hooks are each supported on a very long two-jointed proleg.

Pupa. (Pl. 13, fig. 8) Length 12 mm. Width 2 mm. Antennae 7 mm. Wings 4 mm. Head and thorax yellowish white; antennae and legs yellow; abdomen pinkish with slightly darker band on the middle of the dorsal side. A single respiratory filament occurs on each side of the first segment. A pair of filaments occur in similar position on the second, third and fourth segments. The hairy tibial spurs on the legs, are 3, 4, 4 on the first, second and third pairs respectively. The body ends in two blunt, hairy, appendages of two lobes each. Hooks pointing backward occur in two rows on the dorsal side of the third, fourth, fifth, sixth and seventh segments at the anterior edge. Two plates with spikes pointing forward are found at the posterior edge of the fifth segment.

Eggs. Eggs of this species laid by an adult which was bred, are shown in plate 13, figure 11.

Hydropsyche species? (near p h a l e r a t a Hag.)

Plate 15, figures 1–4, 7

Habitat. Larvae and pupae found in rapid currents in Little Clear creek. Adults settled in great numbers on the hatchery windows.

Occurrence. Abundant throughout the period.

Case. No larval case, only strands of silk between the rocks. Pupal case (pl. 15, fig. 4) of rather coarse stones fastened to larger stones or other supports.

Larva. (Pl. 15, fig. 3) Length 16 mm. Width 3 mm. Head brownish yellow. A dark brown patch in front, and in the center of this, a horseshoe shaped, yellow mark opening posteriorly. Labium almost black. Prothorax brownish yellow margined with black. Mesothorax same except that the black margin is not complete. Instead, there is a semicircular black line at posterior margin. Mesothorax is similar with black spot instead of the semicircle. Legs yellow with white spots on coxa and femur. Abdomen white, the dorsal side thickly set with blunt, brown hairs. No tubercles on the first segment. Filaments occur only on the ventral side. They are set in two rows on the mesothorax, the

metathorax and the first seven segments of the abdomen. Two stalks occur together on each side of the segment, and these are in turn divided into six or nine filaments. Instead of four stalks the mesothorax has two, the metathorax three and the seventh abdominal segment one. Two brown spots are very prominent on the ventral side of the eighth and of the ninth segments. The anal hooks are on very large prolegs of one joint each. A bunch of hairs is at the base of each hook. One or two stout hairs arise near the base of the hook and extend to meet its point.

Pupa. Length 11 mm. Width 2 mm. Head pinkish. Thorax white. Spurs on the tibiae arranged in the order 1–4–4. Abdomen white with brick red on the dorsal side. Hooks pointing backward are on the third, fourth, fifth, sixth, seventh and eighth segments. Plates with spurs pointing forward are on the third and fourth segments. I was able to make out but eight abdominal segments in this pupa.

1 **Halesus** species?

Plate 32, figures 3, 6; plate 33, figure 3

Habitat. Larvae and pupae were found in Little Clear creek and along the shore of Little Clear lake, specially on wood strewn bottoms.

Occurrence. Larvae were quite plentiful during the entire period. Pupae were obtained only at the last. Only two or three adults were seen and those during the last week of work. A single specimen of this species was bred Aug. 31, 1900.

Case. (Pl. 33, fig. 3) Case of thin pieces of wood placed at right angles to the length of the case with their ends crossed. The coarseness of the material used varies but is uniform for each case. Length 18 to 20 mm. Width 7 mm.

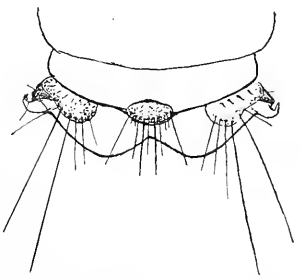


Fig. 37 Dorsal view of end of abdomen of larva

Larva. (Pl. 32, fig. 3) Length 15 mm. Width 4 or 5 mm. Head brownish black with broad white stripes running obliquely from the corners of the mouth along both dorsal and ventral sides of the eyes. There is a white spot where the inner pair of stripes would unite if continued. The anterior half of the dorsal side of the prothorax is black, the posterior half white. The mesothoracic shield blackish brown bordered with black. Metathorax yellow with large brown spots. Legs yellow with triangular white spot on the outside of each femur at its joint with the tibia. Two spurs on each tibia. Abdomen purplish, whiter beneath. Anal hooks are on

single jointed prolegs. The position and number of respiratory filaments may be represented diagrammatically.

	Dorsum				Venter			
1								
2	3	3 3	3 3	3	3	3 3	3 3	3
3	3 2	3 3	3 3	3 2	3	3 3	3 3	3
4	2	2 2	2 2	2	2	3 3	3 3	2
5	1	2 2	2 2	1	1	3 3	3 3	1
6		2 2	2 2			2 2	2 2	
7						2 1	2 1	
8								
9								

Pupa. (Pl. 32, fig. 6) Length 16 to 18 mm. Width 4 to 5 mm. Antennae as long as the body. Wings 10 mm. Head yellow, thorax white. Spurs on the tibiae occur in order 1–3–3. Abdomen white with dull brick red on the dorsal side, specially on the anterior segments. Filaments are also of a dull brick red color. Hooks pointing backward are on the third, fourth, fifth and sixth segments. Plates with spikes pointing forward are at the posterior edge of the fifth segment.

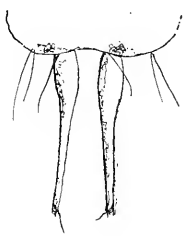


Fig. 38 Caudal processes of the pupa

Eggs. The eggs of this species are laid in a compact cluster with abundant gelatin. A cluster of about 300 eggs was kept till the larvae hatched and their identity was shown by the characteristic cases they made.

OTHER LARVAE FOUND AT SARANAC INN

(ARRANGED BY FAMILIES)

LIMNOPHILIDAE

2 **Halesus** species?

Plate 32, figure 2 and 5; plate 33, figure 2

Habitat. Larvae and pupae found in Little Clear creek. The pupae are commonly fastened to submerged tree branches closely resembling broken twigs.

Occurrence. Larvae common throughout the period. Pupae not found till the very last.

Case. (Pl. 33, fig. 2) Case of irregular pieces of wood placed longitudinally with slender stick extending beyond the posterior end. Length 23 mm. Width 8 mm. Length of stick beyond the case about 19 mm.

Larva. (Pl. 32, fig. 2) Length 18 mm. Width 4 mm. Head, prothorax and mesothorax reddish brown with a pattern of black spots. Mesothorax has right angled black lines in the posterior corners. Metathorax is yellowish brown. Legs brown, margined with black. Spurs on the tibiae arranged in order 2–2–2. Abdomen whitish with red patch on the dorsal side. Respiratory filaments occur with or near the divisions between the abdominal segments. Beginning at the division between the first and second segments, they occur in the following order on the dorsum, 0, 0, 3, 3, 2, 1, 0, 0, 0. On the ventral side their arrangement is 0, 0, 3, 3, 3, 2, 2, 1, 0. Anal hooks are on two-jointed prolegs.

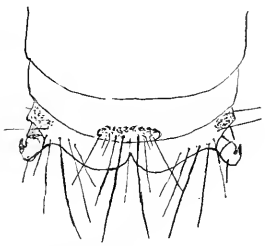


Fig. 39 Dorsal view of end of abdomen of larva

Fig. 40 Lateral fringe of an abdominal segment of the larva

Pupa. (Pl. 33, fig. 5) Length 19 mm. Width 4 mm. Antennae 16 mm. Wings 8 mm. 3 ocelli. Head reddish yellow. Thorax and legs yellow. Spurs on the tibiae arranged in order 1, 3, 3. Black spines numerous on the legs. Abdomen white with reddish brown above and yellow beneath. Heavy black fringe along the rear four segments. Hooks pointing backward on the anterior edge of third, fourth, fifth, sixth and seventh segments. Plates with spikes pointing forward at the posterior margin of fifth segment. Respiratory filaments remain.

3 **Halesus** species?

Plate 32, figures 3 and 6; plate 33, figure 3

Habitat. Larvae and pupae found in Little Clear creek.

Occurrence. Larvae quite common throughout the period. Pupae found only during the last four days of the session.

Case. (Pl. 33, fig. 3) Cylindric case of wood and sand or small stones, often finely colored. Length 24 mm. Width 6 mm.

Larva. (Pl. 32, fig. 3) Length 16 mm. Width 4 mm. Fewer black spots on head but otherwise same as larva just described. The length of the pupae of this species would seem to indicate that the larvae taken were not full grown.

Pupa. (Pl. 32, fig. 6) I could distinguish no difference between this and the pupa just described.

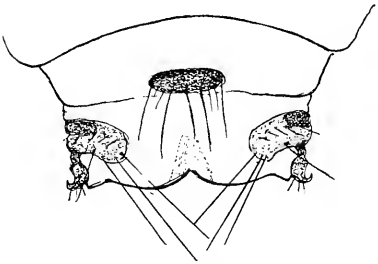


Fig. 41 End of abdomen of larva

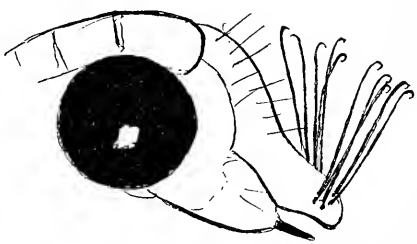


Fig. 42 Head of pupa, showing "moustache"

4 **Halesus** species?

One specimen found.

Case. This larva was found among some of no. 3 of this genus and presumably was accidentally placed there because of similarity of case.

Larva. Length 18 mm. Width 5 mm. Head, prothorax and mesothorax yellowish brown spotted with black. Mesothorax has a black mark like that of no. 1 and 2. Abdomen white with brick red on dorsal side. Legs have white spot on the outside of the femur at the joint with the tibia. A white dot occurs at the anterior edge of each half of the third, fourth, fifth, sixth and seventh segments. Anal hooks are on two-jointed prolegs. The respiratory filaments occur in position and number indicated in the diagram.

	Dorsum				Venter			
1								
2	2	3	3	2		3	3	
	2	3	3	2	3	3	3	3
3	3	3	3	3		3	3	
		3	3		2	3	3	2
4	2	3	3	2		3	3	
		3	3		2	3	3	2
5	1	2	2	1		3	3	
		2	2		2	2	2	2
6		2	2			2	2	
		2	2		2	2	2	2
7		2	2			2	2	
		2	2		1	2	2	1
8		1	1					
9								

SERICOSTOMATIDAE

1

One specimen taken from hatchery trough June 19, 1900.

Case. Cylindric yellow case slightly curved, composed mainly of silk with multitudes of spicules of fresh-water sponge. Length 10 mm. Width tapers from 3 at the anterior end to 2 mm. at the posterior end.

Larva. Length 8 mm. Width 1.5 mm. Head and thorax light yellow. Lines of black chitin over each side of the mesothorax and also on the dorsal side of the first segment, extending obliquely over the lower tubercles. Numerous respiratory filaments occur on the second, third, fourth, fifth, sixth and seventh segments both above and below. The anal hooks are supported on two-jointed prolegs.

2

One specimen taken from hatchery trough June 19, 1900.

Case. Length 8 mm. Tapers from 3 to 1 mm. in diameter. Composed of small pieces of wood or bark and is of a straight cylindric shape.

Larva. Length 7 mm. Width 1 mm. Head and prothorax yellowish brown with numerous lighter dots. Mesothorax and metathorax white. A black line curved outward is on each half of the dorsal side of the mesothorax. Black line on margin of each coxa. In case of the second and third pairs of legs this line extends nearly to the rear margin of the mesothorax and metathorax. Abdomen white. On the first abdominal segment a black line runs from the rear of the segment downward to the top of the lower tubercles. Numerous small filaments occur on the second, third, fourth, fifth, sixth and seventh segments on both dorsal and ventral sides. The two two-jointed prolegs each supports a single large hook with a smaller one at its base.

LEPTOCERIDAE

1

One specimen taken June 19, 1900.

Case. Cylindric case of bark slightly curved. Length 11 mm. Width 1 mm. A slender piece of light colored wood is fastened along one edge, extending two or three mm beyond the case at each end, and a rectangular piece of wood is fastened to the case at the rear end on the side opposite the slender stick.

Larva. Length 7 mm. Width 5 mm. Head and thorax yellowish white with a pattern of dark brown spots. The legs are long and slender. Abdomen is white. The ninth segment is incircled by a row of spines pointing backward. There are no respiratory filaments. The two single-jointed prolegs each have four hooks.

CASES FOUND WITHOUT LARVAE OR PUPAE

1

Case composed of pieces of wood 7 mm long placed lengthwise in a spiral band. This case has three complete turns of the band. Diameter tapers from 8 to 6 mm. Found in Little Clear creek July 14, 1900. This case was evidently of a Phryganeid larva.

2

Slightly curved cylindric case of very fine sand. Length about 15 mm. Diameter decreases from 3 to 2 mm. Found in very great abundance in Bone pond.

3

Tubular case, slightly curved, composed mainly of silk closely woven with some material resembling the bark of young twigs, having a yellow appearance within and brownish black without. Length 15 mm. Diameter decreases from 3 to 2 mm. Found in hatchery trough June 19, 1900.

4

Cylindric case of small pieces of wood. A large, flat, rectangular piece of wood 10x12 mm is beneath the forward end. A long round piece runs along the upper side. Length of this piece 10 mm; diameter 2 mm. The case proper measures 10 mm, with a diameter of from 4 to 6 mm.

5

Case of hemlock leaves fastened by their bases. The other ends stand out obliquely from the case. Length 17 mm. Diameter 8 mm.

6

Cylindric case made of silk with bits of bark; a hemlock leaf lies flat on each side of the case. Length 11 mm. Width 2 mm.

LIST OF ADULT CADDIS FLIES FOUND AT SARANAC INN

Phryganeidae

Phryganea cinerea Hag. (pl. 30, fig. 1) August 5
Phryganea vestita Walk. July 25
Neuronia dossuaris Say. August 10
Neuronia postica Walk. July 16

Limnophilidae

Limnophilus ornatus Banks July 18
Goniotaulius dispectus Walk. ? (pl. 30, fig. 2) August 8
Goniotaulius pudicus Hag. July 18
Halesus indistinctus Hag. (pl. 30, fig.3) August 14
Halesus hostis Hag. (pl. 31, fig. 1) July 30
Stenophylax scabripennis Ramb. July 22
An undetermined Limnophilid. August 20

Leptoceridae

Molanna cinerea Hag. (reared) (pl. 13, fig. 1–6) July 6 to August 20
Triaenodes ignita Walk. (pl. 34, fig. 2) July 16, 18
Leptocerus *species?* August 4
Leptocerus *species?* (*near* flaveolata) June 29, July 7
Leptocerus resurgens Walk. (pl. 34, fig. 1) July 2, August 8
Mystacides nigra Linn. August 1

Hydropsychidae

Hydropsyche scalaris Hag. (pl. 34, fig. 3) July 3, August 12
Hydropsyche *species? near* phalerata (reared) (pl. 15, fig. 1–4) July 5, August 14
Polycentropus lucidus Hag? (reared) (pl. 13, fig. 7–11) July 7, August 19

Rhyacophilidae

Chimarrha aterrima Walk. July 15, 19
Chimarrha *species?* July 18

Order DIPTERA

Of this immense group a considerable part is aquatic. That part is abundantly represented at Saranac Inn, but did not receive a fair measure of attention. Dipterous larvae, comparatively speaking, are somewhat better known than are the immature stages of the "lower" orders to which we gave our principal attention. Only those Diptera which in their immature stages were most accessible, or seemed likely to yield new or interesting forms, were studied. Below is an annotated list of the groups which came more or less under observation.

Tipulidae—Crane flies. Abundant in individuals, representing a considerable number of species. No attempt was made to determine the few specimens collected, save the giant Tipula abdominalis Say, whose larva is described below. A small species with beautifully spotted wings was bred from a floating pupa, but the single, imperfect, alcoholic specimen is insufficient for description. During the month of

July numerous pupal cases of an unknown species were seen sticking out between the boards which covered the bank of the creek beside the hatchery. Many larvae and pupae of the singular Bittacomorpha clavipes were collected from the rotting vegetation in little shallow bays in the borders of Little Clear creek, where they were very abundant; the imagos were seen commonly, also, gliding slowly along through the air with a singularly phantom-like appearance and motion. The few that retained their six caducous legs after pinning are in the state collection at Albany.

Chironomidae and *Culicidae*—gnats, mosquitos, midges, etc. These families were abundantly represented, and a goodly number of species were reared, but, unfortunately, there has not been opportunity for the preparation of descriptions in time for incorporation into this report.

Mycetophilidae. During the last days of our session the large Asindulum montanum Roeder was common in the hatchery windows.

Simuliidae. The single, unobtrusive species, S. venustum Say, was very common; during the earlier part of our session the hatchery windows, specially the windows nearest the inflow pipes, swarmed with them. Some new observations on the oecology and habits of the black fly in its earlier stages are recorded on pages 407–8 and illustrated in plate 15, figures 9–11, 18–20.

Stratiomyiidae. Soldier flies. But few specimens were taken belonging to this family. These belonged to two very interesting species, one to our largest and handsomest, Stratiomyia badius Walk., whose larva is described on page 576; and the other, one of the smallest members of the family, representing a new genus and species, is described below by D. W. Coquillett, and named by him Zabrachia polita.

Empididae. A new genus and species was found in its immature stages associated with Simulium in rapids and reared: it is described below by Mr Coquillett as Roederiodes juncta. Hilara mutabilis Loew was common about the shores of Lake Clear during the last week in June. Little companies would start before one's feet when approaching the edge of the water, disperse and settle again near by.

Sciomyzidae. Two interesting swale flies, Sepedon fuscipennis Loew and Tetanocera pictipes Loew, were reared in large numbers. Their larvae and pupae are figured and described herewith. These were from below the hatchery on Little Clear creek. Above the hatchery, nearer the railroad in the natural meadow beside the water, were collected, while sweeping, several additional species of Tetano-

cera, whose immature stages were not observed: T. boscii Desv. T. saratogensis Fitch, and T. clara Loew.

Ortalidae. All along the above mentioned creek the handsome fly, Melieria (Ceroxys) similis Loew, was very common in the grass; it was always abundantly represented in sweepings. Its immature stages were not observed.

Tabanidae. These should be mentioned if only for their abundance. We collected quite a number of species from the hatchery windows; we obtained many larvae but did not undertake to rear them; all these were sent, undetermined, to the state collection.

Conopidae and *Bombyliidae.* It may be worth while mentioning that the splendid wasp-mimicker, Physocephala furcillata Will, was a very common insect on the flowers of thistle and goldenrod, and that a number of species of bombyliids flitted in numbers along every roadside and path through the forest.

Tipula abdominalis Say

Plate 35, figure 2

1823 Tipula abdominalis Say, Acad. nat. sci. Phil. Jour. 3:18 (The original description is excellent.)
1828 Ctenophora abdominalis Wiedmann, Aus. zweifl. ins. 1:37
1848 Tipula albilatus Walker, List dipt. ins. Brit. mus. 1:65
1859 Ctenophora abdominalis Leconte, Complete writings T. Say, 2:45
1878 Tipula abdominalis Osten-Sacken, Cat. Dipt. N. Am. p. 37 (listed)
1900 Tipula abdominalis? larva, Johnson, Ent. news. 11:578 (note)

This giant crane fly was not raised. It was common about the hatchery during August, and the workmen, impressed by its great size and sprawling attitudes, frequently brought in specimens picked from the sides of the building. In the borders of the creek back of the hatchery were found numerous tipuline larvae so large they could hardly belong to any of our species except this one. They certainly could not be the larvae of any other species we found at Saranac Inn. Therefore, I have referred them by supposition to this species, and give herewith a description and figures.

These larvae were associated with Bittacomorpha clavipes in shallow bays filled with red-rotten trash in the edges of the creek, various sizes from half grown to full grown occurring together. Pupae were not found.

Larva. Pl. 36, fig. 1, 2. Length 51 mm; diameter 6 mm.

Body cylindric except at ends, tapering anteriorly on the thoracic segments, a little less narrowed on the two posterior segments abdominal.

Head retracted within the prothorax, only the blunt tips of the antennae showing at the sides.

Color greenish brown, darker toward the head and on the dorsum of the penultimate segment, paler on the ventral surface, and most transparent on the sides of the body.

Each of the middle abdominal segments has a secondary transverse groove at two thirds its length, and on its posterior third a transverse line of setigerous tubercles, from which another line extends anteriorly at the sides of the dorsum; the seta at the posterior end of this lateral row is much longer than any of the other setae. The yellow color on these setigerous ridges forms the basis of the color pattern, which consists elsewhere of multitudinous spots that are mainly arranged symmetrically in pairs.

Anal prominence pale yellowish, bearing at its sides three pairs of similar, equal appendages, each about as long as the greatest diameter of the body. The respiratory disk bears three pairs of marginal lobes or teeth, and, between the base of the lowermost or ventral pair and the anal prominence, a conspicuous, setigerous tubercle. The six marginal lobes are all blunt at the apex, where they bear a few, fragile hairs, and are covered except on the posterior face with a close, brownish pubescence. Paired black lines extend up the posterior face of each lobe, and at the base of these lines there is, on each lobe of the lowermost pair, a pair of black spots. Between the brown, cup-shaped, spiracular openings there is a pair of black marks.

Saranac Inn, Little Clear creek, July and August 1900.

Stratiomyia badius Walker

Plate 35, fig. 1

1849 Stratiomyia badius Walker, List dipt. ins. Brit. mus. 3:529

1849 Stratiomyia ischiaca (Harr.) Walker, List dipt. ins. Brit. mus. 3:529

1866 Stratiomyia picipes Loew, Centur. 7:21

1878 Stratiomyia picipes Osten-Sacken, Cat. Dipt. N. Am. p. 48 (listed)

1895 Stratomyia badius Johnson, Am. ent. soc. Trans. 22:243 (a full description)

This fine soldier fly was not uncommon along the railroad track east of the Saranac Inn station on small clumps of goldenrod during August. On August 12 Dr O. S. Westcott and I collected a few, finding them associated with the wasp-mimicking conopid, Physocephala furcillata Will., and wasps of many species and cerambycid beetles. The flower clumps were rather few and small, and collecting from them was excellent.

A single stratiomyiid larva was taken during the season. It clearly belonged to the genus Stratiomyia, of which this was the only species observed.

Larva. Length of body 27.5 mm, caudal tuft of plumose hairs 2 mm additional; greatest diameter (across base of abdomen) 4 mm; width of head 1.7 mm. Color uniform blackish.

Head depressed, in outline conic as seen from above; mouth parts inserted in a rectangular notch at its anterior end, the hind margin of the notch straight or nearly so; from the hind angles of the buccal notch there extends posteriorly on the top of the head a pair of grooves, parallel or a little convergent for two thirds of their length, where connected by a transverse groove, thereafter divergent toward the hind angles of the head; the depth of the buccal notch equals one fourth of the length of the head; the sides of the head are rugulose. The head bears setigerous punctures as follows: a pair on the hind angles of the buccal notch, a pair posterior to these between the grooves, a postocular pair, and a subocular pair, and two pairs still lower on the sides of the head.

The anterior third of the thoracic segments (which become successively wider from the front) is closely beset with whitish recurved hairs, which disappear on the foremost abdominal segments; there are a few long straight hairs at the lateral margins of all the body segments excepting the the last, which bears on its lateral margins a line of pubescence. Hairs of caudal circlet plumose their whole length, yellowish with a blackish tinge just beyond the base.

This larva differs from that of Str. norma Wied. as figured and described by Hart[1] farther, in that the prothorax is longer than meso or metathorax, the anal groove on the ventral side of the caudal segment is closed and obsolete for the greater part of its length, only the T-shaped anterior third of it remaining; there are no paired markings beside it, and there are no grooves on the ventral side of the two preceding segments.

Stratiomyia seems to differ as a larva from Odontomyia, in the squarely cut hinder margin of the buccal cleft, in the absence of ventral hooks from the apices of the penultimate and antepenultimate segments as well as in the greater elongation of the last segment indicated by Hart.

A single larva was obtained from the surface of Little Clear creek back of the hatchery building July 27, 1900. It was an old larva, perhaps in transformation to puparium. A younger larva would probably have shown something more of color pattern; structural characters, however, should be as described.

During the last fortnight of our session a few specimens of a minute soldier fly were picked from the hatchery ceiling, where at first they were mistaken for Simulium, till a more careful glance discovered their rotundity of outlines. These proving to be new to science, D. W. Coquillett has, at our request, prepared the descriptions given on p. 585.

Sepedon fuscipennis Loew

Plate 14, fig. 1–8

1859 Sepedon fuscipennis Loew, Wiener ent. monatschr. 3:299
1862 Sepedon fuscipennis Loew, Monographs Dipt. N. Am. 1:124
1878 Sepedon fuscipennis Osten-Sacken, Cat. Dipt. N. Am. p. 178 (listed)

This species is reported in Osten-Sacken's catalogue from the middle states. There are specimens of it in the Museum of comparative zoology

[1] Ill. lab. nat. hist. Bul. 4:249–52, pl. 14, fig. 57.

from the District of Columbia, from Cambridge Mass. and from Norway Me. It was quite common at Saranac Inn in Little Clear creek, in places where the creek flows through beds of bur reed, S p a r g a n i u m, intermixed below the surface of the water with river weed, P o t a m o g e t o n, and algae.

The flies sit on the erect burred leaves, with wings laid flat on their backs, their long hind legs folded together, the tip of the abdomen sloping down and nearly touching the leaf and the head lifted up high above it, in quite a froglike attitude. They fly but little—that little rather poorly—sweeping betimes, from one resting place to another near by. They rest on the leaves head downward more often than otherwise; I have frequently seen them sitting thus, close to the surface of the water, and apparently feeding on the stuff which collects about the bases of the leaves just above the water line.

Nothing has been written concerning the life histories of any of our few American species. When, in the course of a quantitative study of a little section of the creek border, I first noticed the singular pupae, after handling them for half an hour and throwing a number aside, having mistaken them for floating seeds (see pl. 14, fig. 4 and 6), and when I found also the larvae, likewise floating, exhibiting a muscid anterior and a tipuloid posterior end, and hook-bearing, dorsal prolegs for crawling beneath the surface film, I was sure I had found something of which I had read no account, and something it would be worth while to raise, if possible. So I stocked several of my floating cages (fig. 1) with larvae and pupae.

When imagos had emerged and had been determined, I found in Brauer's list of the described transformations of Diptera[1] that immature stages were known for two European species of the genus: S. s p h e g i u s and S. s p i n i p e s; but I have not been able to find the paper in which these are described[2].

Larva. (Pl. 14, fig. 1, 2.) Length full grown 11–12 mm; greatest diameter 2 mm.

Color yellowish or greenish brown of varying depth in different specimens, with tracheae showing through the thin integument more or less distinctly.

Body cylindric, strongly tapering anteriorly from the second abdominal segment, slightly tapering on the upturned posterior end behind the seventh abdominal segment; skin granular; head segment minute, blackish, retractile within the prothorax; the thoracic segments strongly retractile and protrusible, almost telescopic; mesothoracic twice as long, and meta-

[1] Brauer, F. (Syst. studien Dipt. larv.) Denkschr. math-nat classe k. acad. wiss. Wien. 1883. 47 :1–100, 5 plates.

[2] Gerke. Vehr. d. nat. unterhalt. Hamburg 1876. 3: 145, pl. 3.

thoracic three times as long as the prothoracic segment, smooth except for a single piliferous tubercle each side.

Abdominal segments 1–7 similar, and of nearly equal length, each bearing three rings of tubercles, a median ring of tubercles of moderate size, and at each end close beside the suture separating the segments a ring of minute tubercles; median ring, with the pair of tubercles beside the middorsal line (pl. 36, fig. 3*a*) very mobile, transversely elongated, bearing a stiff brush of recurved or hooked bristles, well adapted for crawling beneath the surface film; on the ventral side, two pairs of prominent rounded tubercles; between the dorsal and the ventral there are on either side four or five lesser tubercles, mostly unisetigerous, sometimes not very distinct, the third of them, counting from above, a little out of line, in advance of the others. There is a broad median ventral lobe on the eighth abdominal segment, liplike rounded, covered with very minute recurved prickles.

Apex of the abdomen (pl. 36, fig. 3*b*) upturned, flattened, tipuloid, fashioned into a disk which surrounds the fringed respiratory apertures. There are two pairs of long processes on the ventral half of the margin of the disk and three pairs of low tubercles on the dorsal half of it. The two submedian ventral processes are long, triangular, almost lanceolate, simple; those of the pair external to these are two-jointed, the joint midway their length; both pairs are pilose, and about equal in length to the diameter of the disk. Respiratory apertures in two groups of three each, slitlike, radiating in arrangement. From the notches between the apertures and at their sides arise tufts of black, floating filaments arranged in a flat whorl, well adapted to holding the breathing apertures up to the surface of the water; these filaments are black, dichotomously (often irregularly) four or five times branched, about 10 or 12 in number, and extending almost to the margin of the disk.

The larva when undisturbed lies quietly at the surface of the water amid a tangle of vegetation. It can swim when disturbed, and its swimming is most curious. It pulls itself below the surface, turns over on its back, and then progresses by bending and straightening its body, striking the water sharply with the flat face of its caudal disk.

Puparium. (Pl. 14, fig. 3–5). Length 6 mm; greatest horizontal diameter 3 mm; vertical diameter 2.5 mm.

Color reddish brown, closely marked with yellowish on the ventral side. Body shaped like an undetermined seed, which was not uncommon, floating on the surface of the creek. I first mistook the pupae for seeds, and afterward occasionally mistook seeds for pupae, so good was the resemblance.

Body ovate, dorsally flattened and ventrally rounded, broadly canoe-shaped, but suddenly contracted anteriorly into a flat, truncate, rostral prominence .5 mm wide and .9 mm long. There is a black, middorsal curved mark (concave anteriorly) just behind the base of this beak. (When the imago emerges, this beak splits down its sharp lateral margins, and across the dorsum of the body near to the aboved mentioned black mark, and comes off as one half of the cap.)

The posterior end is suddenly, and strongly contracted into a cylindric tail, which is directed upward at an angle of 75° with the axis of the body. The float of the larva persists on the summit of this tail, and

doubtless continues functional. The fleshy processes and tubercles which surrounded the float in the larva are withdrawn anteriorly in the pupa and flattened down against the sides of this taillike projection so as to be barely distinguishable.

Larvae, pupae and imagos were easy to find through July and August, never in open water, and the imagos were not found away from water.

A single parasite bred from a puparium of this species, sent to Mr Ashmead for determination, proved to be new to science. At our request he has prepared the description of it, given on p. 588. Mr Ashmead says he believes that hitherto nothing has been known of the habits of wasps of the genus Atractodes.

Tetanocera pictipes Loew

Plate 14, fig. 9–14

1859 Tetanocera pictipes Loew, Die nordamerikanischen arten der Gattungen Tetanocera und Sepedon Wiener. ent. monatschr. 3:292
1862 Tetanocera pictipes Loew, Monograph N. Am. Dipt. 1:111
1878 Tetanocera pictipes Osten-Sacken, Cat. Dipt. N. Am. p. 177.

I find no published account of the immature stages of any species in this large genus, save an antiquated one by Dufour for the European species T. ferruginea[1]. The figures are poor. There is an imago of this species, T. pictipes, in the Museum of comparative zoology, reared from the pupa by H. G. Hubbard at Milton Mass. Mar. 27, 1874, and another pupa is pinned beside it. I found larvae, pupae and imagos common at Saranac Inn, associated in all stages with Sepedon fuscipennis. The larvae and pupae are similar to the same stages in Sepedon, but more slender, and with good differential characters; they are apparently entirely similar in habits.

The imagos are found in the same bur reed beds, but they rest on the leaves habitually near the surface of the water, and so are little in evidence. Imagos of Sepedon, while not more common, were much more easily taken. In fact, I should probably not have found imagos of Tetanocera pictipes, had I not, after breeding one, gone out specially to look for them.

Larva. (Pl. 14, fig. 9, 10) Full grown. Length 10–12 mm; greatest thickness 1.8 mm.

Color transparent yellowish or greenish brown, lighter shades prevailing. Body cylindric, tapering anteriorly to a long point, and narrowed a very little just before the disk at the posterior end of the body. The relative lengths of the segments are about as given for the larva of Sepedon. The three rings of tubercles on each of the abdominal seg-

1849 Soc. ent. France. Ann. (2) 7:67, pl. 3.

ments are much the same, but the individual tubercles are in general a little more distinct in T. pictipes; the brush of hooked bristles on the dorsal locomotor tubercles is a little shorter (this is omitted altogether from Dufour's figure of the larva of T. ferruginea); there are four fairly distinct lateral tubercles each side in the median ring of the segment; the subterminal ring of lesser tubercles is less distinct than in S. fuscipennis, except on the ventral side where it is more distinct, and has the pair of little tubercles beside the midventral line fused more or less completely into one.

The respiratory float at the end of the body (pl. 36, fig. 4) is similar to that of S. fuscipennis, but is a little less copiously fringed, and the fringe is a little shorter, reaching but about two thirds of the distance to the margin of the disk. The fleshy processes and tubercles bordering the disk are very different. The ventral, submedian pair of processes are broad and blunt. The lateral processes have a broad obtuse base supporting a slender second joint. The tubercles forming the dorsal border of the disk, excepting the external one each side, are nearly obsolete. By the characters mentioned in this paragraph the larva of this species (possibly, of this genus) may readily be distinguished from Sepedon—at least, from Sepedon fuscipennis.

Puparium. (Pl. 14, fig. 11, 12) Length 6 mm; diameter 2 mm.

Color reddish brown, more reddish on the obsolescent larval tubercles, and on the upper side of the beak into which the body is contracted at the front end. There is no black arcuate mark at the base of the beak on the dorsal side.

Body more slender than in Sepedon, less convex below, less flattened above, though of much the same general appearance. The tail-like prominence at the posterior end bears at its apex the unaltered larval float, and at its sides the scarcely distinguishable remains of the processes and tubercles which surrounded the caudal disk of the larva. This "tail" is bent upward at an angle of about 45° with the axis of the body. By this lesser degree of angulation, as well as by the general slenderness of form, this species is readily distinguished from S. fuscipennis in the pupal stage.

Roederiodes juncta Coquillet

Plate 15, fig. 5–8

The reader is referred to page 586 for the technical description of the imago of this species. It was found in a rapids in Little Clear creek just below the railroad embankment. Larvae and pupae were found first, the former crawling among the pupa cases of Simulium, the latter usually resting within an abandoned Simulium pupa case. After these had been bred, the imagos were found, clinging in companies to the under side of pieces of boards which rested just above the level of the water. They were not seen flying, except when disturbed, and then they took flight slowly and flew poorly. A piece of board might be lifted with a score of the flies sticking to it within an area of a few square inches, and most of them could be gathered into a cyanid bottle before

attempting to escape. The spot on the board where these groups occurred was always a wet one, and on it there was to be seen a mass of very minute white eggs in the midst of a matrix of thin, transparent gelatin. In these companies of adults, males and females were intermingled.

Larva. (Pl. 15, fig. 6) Length 5.7 mm; greatest diameter 1 mm.

Body cylindric, tapering anteriorly on the thoracic segments to the head, which is minute and more or less completely retracted within the prothorax. Segments increasing a little in thickness to the sixth abdominal, and in length to the seventh abdominal.

Color uniform whitish. Skin finely rugulose striate.

There are paired prominent ventral prolegs on the first eight abdominal segments; those on segments 1–7 similar, blunt, cylindric, equaling in length one third the diameter of the abdomen, bearing two terminal rows (of six to nine each) of thin, flat sharp, strongly curved exteriorly directed claws. Prolegs of the eighth segment longer, curved posteriorly, bearing a greater number of thin claws or hooks with apices directed anteriorly, the innermost much the largest.

There are two fine setae on the ventral side of the prothorax near its anterior end. The apex of the abdomen bears two pairs of setigerous processes, and below and at the sides of these a pair of low, bare, blunt prominences. The processes of the upper of the two above mentioned pairs, divaricate, wide apart, as long as the anterior prolegs, bearing each three setae longer than itself. The lower pair shorter, approximated on the apex of the abdomen, each with two shorter setae.

Pupa. Length 4.2 mm.

Free, cylindric, arcuate; clear yellow, with brownish spines and angles.

Face directed ventrally; two pairs of strong setae on the top of the head, with a corrugated surface between them; cases of the antennae simple, short, not exceeding half the length of the face. Mouth parts, wings and legs as usual, the hind legs under the wings. Prothorax at its anterior margin elevated in a pair of pyramidal triangular processes, directed above the hind angles of the head.

There are a few stiff setae on the thoracic dorsum; abdominal segments 1–8 bear each a median transverse whorl of stiff setae, alternating larger and smaller, and becoming much stouter dorsally toward the hind end of the abdomen and much fewer on the eighth segment; ninth segment very short, with a pair of apical lobes, each of which bears a strong, long, ventrally curved hook, as long as segments 8 and 9 together. On the inner side of this hook at its base is a minute, erect spinule.

STRAY NOTES ON OTHER ORDERS

ORTHOPTERA

No effort was made to collect these, but a few that were picked up incidentally were taken to Mr Scudder, who has kindly given me the following list of their names.

Acrididae

Tettix granulatus Kirby. This was not uncommon on the dry lichen mats on Blueberry island in Little Clear pond.

Tettigidea parvipennis Harris. In bogs on sphagnum.

Camnula pellucida Scudder

Dissosteira carolina Linnaeus

Spharagemon sp.? (nymph)

Podisma glacialis Scudder. On bushes in openings in the woods.

Locustidae

Scudderia pistillata Brunner

Xiphidium fasciatum DeGeer

HEMIPTERA

I was struck with the absence of the larger aquatic Hemiptera, such as Belostoma, Zaitha, Nepa, etc., from all the waters in which I did any collecting about Saranac Inn. I was not looking for them; but, if they had ever got into my net, as they have done unfailingly in every other locality in which I have ever collected, they could not but have been seen. Of Ranatra I caught a few specimens in the vegetation about the shores of Bone pond. Of terrestrial Hemiptera there seemed to be no scarcity.

MECOPTERA

Panorpa signifer Banks

Panorpa nebulosa Westw.

These were not uncommon in the damp woods along the road between the railroad and Little Green pond.

COLEOPTERA

Though little attention was paid this order, considerable material was collected. But two species were reared, however: Galerucella nymphae and Donacia emarginata. The latter species was associated with D. subtilis Kunze and D. pusilla Say; and, because of unfamiliarity with the distinctive characters of Donacia larvae and pupae, I have been unable to determine as yet whether I have, among the numerous larvae collected, those of more species than the one that was reared. For the present, I content myself with giving a few biologic notes and figures. Plate 9, from photographs made from life, of Donacia emarginata Kirby on Sparganium in several stages will doubtless be welcome to entomologists. The material for these photographs was obtained while making the second quantitative study detailed in part 2, and farther oecological information is there recorded (see pages 404, 405).

A figure is also given of the singular bug-like Macronychus glabratus in plate 12 (fig. 9) a species commonly found associated

with fresh-water sponges on the under side of submerged logs. I found them mainly on logs which had shed their bark, but this may have been due to the greater ease of discovery on the smooth logs.

HYMENOPTERA

A few representatives of this order, parasitic on aquatic insects, were found. Under the account of Chauliodes on page 547 there has been mentioned the minute egg parasite, Trichogramma minutum which was found a very abundant parasite of the eggs of one species of the above mentioned genus, destroying at least 70% of the eggs.

A new species of Atractodes was found parasitic on the swale fly, Sepedon fuscipennis, mentioned under the account of that species on page 580. A description of the parasite, furnished by Mr Ashmead, under the name Atractodes sepedontis Ashm. is given on page 588.

Four species of parasitic micro-hymenoptera were taken in the first qualitative study detailed above in part 2, page 403, all new to science. Mr Ashmead has at our request furnished descriptions (see pages 586–88).

A few sawflies, collected at random during the summer, were submitted to A. D. MacGillivray, who reports on them as follows.

LIST AND TWO NEW SPECIES OF SAWFLIES

BY A. D. MACGILLIVRAY, CORNELL UNIVERSITY, ITHACA N. Y.

Trichiosoma angulatum Kirby
Tenthredo verticalis Say
Tenthredo rufipes Say
Pachyprotasis omega Norton
Pontania hyalina Norton
Dolerus bicolor Norton
Strongylogaster annulosus Norton

Pachynematus corticosus sp. nov.

♀ Black, with the following parts yellowish rufous, the clypeus, the tegulae, the apical margin of the pronotum, the apices of the coxae, the trochanters, the femora, the tibiae, except the posterior pair at apex, the front and middle tarsi, the middle pair slightly infuscated at apex, apical margin of abdominal tergites two to four, and the venter; the clypeus roundly emarginate, the lobes broad and evenly rounded, the head expanded back of the eyes, the vertex finely punctate, the lateral walls of the ocellar basin sharp and moderately well defined, the frontal crest well developed and not interrupted, the antennal fovea deep and elongate; the antennae elongate, tapering, the third segment slightly longer than the fourth; the sheath broad, its upper margin horizontal,

its lower margin strongly oblique and straight, and its apex broadly rounded; the veins and stigma black, the costa pale at base. Length, 7 mm. Habitat, Saranac Inn N. Y.

Taxonus innominatus sp. nov.

♀ Black, with the following parts rufous: the labrum, the apical half of the mandibles, the femora, the tibia, the front tarsi, the apex of the second, and the entire third and fourth abdominal segments; the tegulae, the apices of the front and middle coxae, and trochanters lutescent; the clypeus deeply roundly emarginate; the third segment of the antennae longer than the fourth; wing veins blackish. Length, 8 mm. Habitat, Saranac Inn N. Y.

ORIGINAL DESCRIPTIONS OF NEW DIPTERA

BY D. W. COQUILLETT, U. S. NATIONAL MUSEUM, WASHINGTON D. C.

ZABRACHIA, gen. nov. Stratiomyiidae

Closely related to Pachygaster, differing chiefly in the shortened, simple third vein. Head in profile only slightly higher than long; face and lower part of the front almost perpendicular; eyes nearly orbicular; antennae shorter than the head, the complex third joint transversely elliptic, the apical, slender style slightly longer than remainder of antennae; third vein of wings simple, terminating at about one third of the length of the second vein beyond the apex of the latter; four posterior cells, a part of each of them bordering on the discal cell. Type, the following species.

Zabrachia polita sp. nov.

Black, polished, the antennae except the styles, also the tibiae, tarsi and apices of femora, yellow, knobs of halteres white, each marked with a black spot on basal half of the upper side; wings hyaline, stigma pale yellowish; length, 2.5 mm. Two females, collected Aug. 8, 1900, by Prof. James G. Needham.

Type. Cat. no. 5344, U. S. national museum

Habitat. Saranac Inn N. Y.

ROEDERIODES, gen. nov. Empididae

Closely related to Clinocera. Face bare, not separated from the cheeks by a groove; cheeks two thirds as broad as the eye hight; proboscis nearly as long as hight of head, rigid, the labella not developed; third joint of antennae oval, pointed at the apex, the apical style about as long as remainder of antennae; no acrostichal bristles, scutellum bearing bristly hairs in addition to the two marginal bristles; wings destitute of a brown stigmal spot, third vein forked, discal cell complete, sending two veins to the wing margin, of which the upper vein is forked,

hind cross vein very oblique, vein at apex of anal cell nearly perpendicular, sixth vein not prolonged beyond apex of anal cell; legs slender, destitute of bristles and of long hairs, pulvilli and empodia well developed. Type the following species.

Roederiodes juncta, sp. nov.

Black, the coxae and femora yellow, tibiae and tarsi brown; head whitish pruinose, the front and upper part of the occiput grayish black; thorax opaque; mesonotum grayish black pruinose, an elongated spot in front of the scutellum and the pleura whitish pruinose; five pairs of dorsocentral bristles, scutellum, except its extreme base, gray pruinose, abdomen opaque, almost velvety; wings grayish hyaline, unmarked; length, 2.5 mm. Three female specimens, also one male without a head. Collected July 29, 1900, by Prof. James G. Needham. (Plate 15, figures 5–8)

Type. Cat. no. 5345, U. S. national museum

Habitat. Saranac Inn N. Y.

This genus is apparently nearest related to the European genus Roederia Mik, from which it differs in the absence of the stigmal spot and of the long hairs near the apices of the front femora; the venation also is different.

DESCRIPTIONS OF FIVE NEW PARASITIC HYMENOPTERA

BY WILLIAM H. ASHMEAD, ASSISTANT CURATOR, U. S. NATIONAL MUSEUM

Family 56 SCELIONIDAE

TELENOMUS Haliday

Telenomus longicornis sp. nov.

♂ Length 1.4 mm. Polished black; the antennae are much longer than the body, as in T. dolichocerus Ashm. the flagellum brown-black, hairy, the first joint of same being about the length of the third, the second joint very long, much longer than either the first or third, the fourth a little shorter than the third, the following joints very imperceptibly shortening. Wings hyaline, iridescent, the veins brown, the tegulae black. Legs black, the trochanters and tibial spurs pale yellowish, a dot on knees testaceous, the tarsi fuscous. Abdomen normal, the first segment longitudinally striate, the following smooth and polished.

Type. Cat. no. 5365, U. S. national museum

Habitat. Saranac Inn N. Y. One specimen taken in June 1900, by Prof. James G. Needham.

Family 77 ALYSIIDAE

BRACHYSTROPHA Förster

Brachystropha quadriceps sp. nov.

♂ Length 1.8 mm. Polished black; mandibles rufous, palpi white; antennae black, 23 jointed, the scape beneath reddish, the extreme apex of the pedicel yellowish white; legs flavo-testaceous, the tibiae and tarsi darker, more of a reddish color, the tarsi fuscous. Wings hyaline, iridescent, the stigma and veins dark brown, the stigma subtriangular in shape, wider than the first abscissa of the radius and scarcely extending to half the length of the marginal cell.

The head is quadrate, with the temples broad, full, the face below the antennae smooth, impunctate, but with a delicate median ridge. The median fovea on the mesonotum posteriorly, so conspicuous in many forms, is very minute, nearly obsolete. The scutellum is bifoveate at base. The metathorax is rugulose, bare, but with a median carina. The mesopleural suture is distinct, crenate. The abdomen is clavate, the petiole being long and striate with prominent spiracles, the following segments all smooth, shining.

Type. Cat. no. 5366, U. S. national museum

Habitat. Saranac Inn; N. Y. One specimen in July by Prof. James G. Needham.

RHIZARCHA Förster

Rhizarcha astigma sp. nov.

♀ Length 2 mm. Polished black; mandibles rufous; palpi white; antennae black, 24 jointed, the scape and pedicel rufo-piceous, the latter narrowly yellow at apex; legs rufo-testaceous, the coxae and trochanters paler, more or less pale yellowish; wings hyaline, the veins brown.

The face below the antennae is feebly punctate and with a short median carina. The mesonotum posteriorly has a median fovea and a short grooved line just in front of the scutellum. The scutellum is bifoveate at base. The metathorax is rugulose but so densely clothed with a pale pubescence as to be obscured and the sculpture overlooked. The stigma in the front wings is not developed, being narrow and linear as in Aspilota. The mesopleural suture is distinct but smooth, not at all crenate. The abdomen is oblong oval, scarcely as long as the head and thorax united, the ovipositor not prominent, at the most subexserted, the first segment longitudinally striate, those beyond smooth and shining.

♂ Differs from the ♀ in having the antennae longer, 26 jointed, while the legs are slightly differently colored, the extreme apices of the middle and the hind tibiae and their tarsi being fuscous.

Type. Cat. no. 5367, U. S. national museum

Habitat. Saranac Inn N. Y. Taken in June and July by Prof. James G. Needham.

Family 78 BRACONIDAE

APHIDIUS Nees.

Aphidius nigripes sp. nov.

♂ Length 1.5 mm. Entirely black except as follows: the extreme apex of the clypeus, the mandibles, the second joint of the trochanters and the knees are honey-yellow, the tibiae and tarsi dark brown or fuscous, almost black. The antennae are 19 jointed, longer than the body, the joints of the flagellum being not quite thrice as long as thick. Wings hyaline; tegulae and veins brown, the stigma *within*, the recurrent nervure, the transverse cubitus and the second abscissa of the radius being pallid or subhyaline.

Type. Cat. no. 5368, U. S. national museum

Habitat. Saranac Inn N. Y. Taken in June and July by Prof. James G. Needham.

This species in a table of our species, prepared for my *Monograph of the North American Braconidae*, falls next to A. obscuripes, but is distinguished by the color of the legs and differences in antennal characters.

New stilpnine parasitic on dipterous puparia

Atractodes sepedontis sp. nov.

♀ Length 5 mm. Black, with the second and third abdominal segments, the mandibles, and the legs, except the hind tarsi rufous; hind tarsi dark fuscous or black. Antennae 21 jointed, black, the third joint the longest, a little longer than the second, the following gradually and almost imperceptibly shortening. Head and thorax polished, the parapsedal furrows well defined anteriorly, gradually becoming obsolete posteriorly before attaining the base of the scutellum. Mesosternum and metathorax rugulose opaque, the latter sloping from the base to apex, with the basal lateral and pleural areas alone well defined. Wings hyaline, the stigma and veins dark brown, the tegulae, the median and submedian veins in the front wings toward the base and the subcostal vein in the hind wings

yellowish; areolet open, the submedian cell a little longer than the median. Abdominal petiole about twice as long as the hind coxae, bifurrowed and subcoriaceous above.

Type. Cat. no. 5316, U. S. national museum

Habitat. Saranac Inn N. Y.

Host. Diptera: Sepedon fuscipennis Loew. Bred Aug. 24, 1900, from a puparium of Sepedon fuscipennis Loew, by Prof. James G. Needham.

This species comes very close to the European Atractodes gravidus Haliday; but is readily distinguished by a slight difference in color and by decided differences in antennal and metathoracic characters.

EXPLANATION OF PLATES

PLATE 1

Outlet of Little Clear pond; view, looking northward from the railroad. Photo by J. G. Needham

PLATE 2

Little Clear pond; view from the outlet, looking toward Green hill: St Regis mountain in the distance. Photo by J. G. Needham

PLATE 3

Little Clear creek on the grounds of the Adirondack hatchery; looking down stream from the railroad. Photo by C. Betten

PLATE 4

Little Clear creek just below the hatchery. Photo by R. C. Spears

PLATE 5

Little Clear creek at the edge of the woods below the hatchery; cages, nets and trap lantern. From the bare strip partly occupied by a single screen cage in the foreground the first quantitative study detailed in part 2 was made. Photo by J. G. Needham

PLATE 6

Little Clear creek on the hatchery grounds, looking toward the railroad. From the boarded bank of the pool in the foreground the dragonfly exuviae were collected for the count recorded in part 2. Photo by J. G. Needham

PLATE 7

View across Little Bog pond, from the "carry". Photo by J. G. Needham

PLATE 8

Shore of Little Bog pond. Photo by C. Betten

PLATE 9

Bur reed (Sparganium) with long-horned leaf beetles (Donacia emarginata Kirby). *a* summit of the plant, with beetle on the leaf (greatly reduced); *b* roots as withdrawn from the water, with larval and pupal cases of the beetle attached (slightly reduced). Photos by J. G. Needham

PLATE 10

FIG. **Leucorhinia glacialis** Hagen

1 Two nymphs on the bottom of the pond
2 The empty nymph skin, left clinging to a branch after transformation
3 The female imago
4, 5 Dorsal and lateral views of the male imago

PLATE 11

Ephemera varia Etn., and **Siphlurus alternatus** Say

FIG.

1 Lateral view of the nymph of E. varia
2 Dorsal view of the nymph of E. varia
3 Lateral view of the male imago of E. varia
4 Dorsal view of the male imago of E. varia
5 Lateral view of the nymph of S. alternatus
6 Dorsal view of the nymph of S. alternatus
7 Lateral view of the male imago of S. alternatus

PLATE 12

Climacia dictyona Needham, nov. sp., and **Sisyra umbrata** Needham, nov. sp.

FIG.

1 Imago of C. dictyona, lateral view, x 4
2 Imago of C. dictyona, dorsal view, x 3
3 Larva of C. dictyona, dorsal view, x 6
4 Pupal cases of C. dictyona, in situ, natural size
5 One of the same, enlarged, showing the hexagonal meshes of the outer covering
6 Imago of S. umbrata, lateral view, x 4
7 Imago of S. umbrata, dorsal view, x 3
8 Two newly formed pupae of S. umbrata, lateral and ventral views, x 6
9 Macronychus glabratus Say (Coleoptera: Parnidae); an associate of the sponge fly larvae, on submerged timbers
10 Fresh-water sponges (Spongilla ?fragilis Leidy) in situ, with the sponge fly larvae crawling about over them
11 Two pupal cases of S. umbrata, showing the closely woven outer covering, natural size

PLATE 13

Molanna cinerea Hagen and **Polycentropus lucidus** Hagen

FIG.

1 Dorsal view of larva of Molanna cinerea, x4
2 Lateral view of larva of M. cinerea, x5
3 Lateral view of the pupa of M. cinerea, x4½
4 Dorsal view of imago of M. cinerea, x4
5 The accustomed resting position of the imago of M. cinerea
6 Ventral view of the flat larval case of M. cinerea, x2
7 Lateral view of larva of Polycentropus lucidus, showing the very long anal prolegs, and the absence of gill filaments, x5
8 Lateral view of pupa of P. lucidus, x6
9 Dorsal view of imago of P. lucidus, x3½
10 Larval case of P. lucidus; tube composed of sand and silk; the enlargement near the end is two layered, and contains the pupa.
11 Eggs laid by P. lucidus female on a stick protruding from the water in a breeding cage

PLATE 14

Sepedon fuscipennis Loew and Tetanocera pictipes Loew

FIG.

1 Larva of S. fuscipennis, dorsal view, x 5
2 Larva of S. fuscipennis, lateral view, x 6
3 Puparium of S. fuscipennis, dorsal view, x 5
4 Puparium of S. fuscipennis, lateral view, x 5
5 Open puparium of S. fuscipennis, x 5
6 A seed floating which the puparium simulates, x 5
7 Imago of S. fuscipennis, dorsal view, x 5
8 Imago of S. fuscipennis, lateral view, x 5
9 Larva of T. pictipes, dorsal view, x 6
10 Larva of T. pictipes, lateral view, x 6
11 Puparium of T. pictipes, lateral view, x 6
12 Puparium of T. pictipes, dorsal view, x 5
13 Imago of T. pictipes, dorsal view, x 5
14 Imago of T. pictipes, lateral view, x 5

PLATE 15

Simulium Society

Simulium venustum Say, Hydropsyche sp.?, Heptagenia pulchella Walsh, Baetis pygmaea Hagen, Leuctra tenella Provancher and Roederiodes juncta Coquillett.

FIG.

1 Two imagos of Hydropsyche sp.?, at rest, natural size
2 Imago of Hydropsyche sp.?, lateral view, x 6
3 Larva of Hydropsche sp.?, lateral view, x 3½
4 Pupal case of Hydropsyche sp.?, x 2
5 Imago of Roederiodes juncta, lateral view, x 10
6 Larva of Roederiodes juncta, lateral view, x 5
7 Pupa of Roederiodes juncta, lateral view, x 5
8 Pupa of Roederiodes juncta in an habitual position in the abandoned pupal case of Simulium venustum
9 Egg masses of S. venustum, and two females ovipositing
10 Pupae, empty pupa skins, and pupal cases of S. venustum
11 Larva of S. venustum, x 5
12 Male imago of Leuctra tenella, dorsal view, x 4
13 Imago of Baetis pygmaea, lateral view, x 5
14 Imago of Baetis pygmaea, dorsal view, x 5
15 Imago of Heptagenia pulchella, x 2
16 Nymph of Heptagenia pulchella, natural size
17 Pupal cases of Hydropsyche sp.?, in situ. natural size
18 Pupae of Simulium venustum, in situ
19, 20 Larvae of S. venustum in situ

PLATE 16

Hexagenia variabilis Eaton

FIG.

1 Female imago, natural size. Photo from life by J. G. Needham

2 Dorsal view of the head of the nymph

3, [a]Fore and [b]hind feet of the nymph; [f]femur; [t]tibia

PLATE 17

Dragonflies

FIG.

1 Aeschna constricta Say

2 Gomphus scudderi Selys

Natural size: photos from life by J. G. Needham

PLATE 18

Dragonfly nymphs: photos by J. G. Needham

FIG.

1 Dromogomphus spinosus Selys

2 Gomphus scudderi Selys

3 G. brevis Selys

4 G. spicatus Selys

5 Ophiogomphus aspersus Morse

6 Lanthus parvulus Selys

7 Hagenius brevistylus Selys

8 Didymops transversa Say

Fig. 1 to 7 are from cast skins.

PLATE 19

Eggs of nine genera of dragonflies (Odonata-Anisoptera)

FIG.

1 Egg of Anax junius Dru: the line k-k indicates the depth of its insertion into cat-tail (Typha) stems.

2 Egg of Hagenius brevistylus Selys

3 Egg of Gomphus descriptus Banks var. borealis Ndm.

4 Egg of Cordulia Shurtleffi Scudd.

5 Egg of Plathemis lydia

6 Egg of Leucorhinia glacialis Hagen

7 Egg of Celithemis eponina Dru.

8 Egg of Perithemis domitia Dru.

9 Egg of Tramea lacerata Hagen

Gelatinous envelops (g) are indicated for all the figures except 1 and 8: all are magnified about 50 diameters.

PLATE 20

Gomphinae

FIG.

1–4 Occiput of the female of Ophiogomphus carolus Ndm., seen from the front, showing variations in occipital spines

5 Genital hamules of O. johannus Ndm., from the left side, inverted

FIG.
6 Genital hamules of O. carolus Ndm.
7 Inferior abdominal appendage of O. carolus Ndm., seen from below
8 Head of nymph of Lanthus parvulus Selys, seen from above and in front
9 Mentum of labium of L. parvulus from above
10 End of abdomen of L. parvulus
11 End of abdomen of Gomphus fraternus Say, nymph
12 Part of labium of G. fraternus Say, nymph
13 End of abdomen of Gomphus pallidus Selys, nymph
14 Part of labium of Gomphus pallidus Selys, nymph
15 End of abdomen of Gomphus spiniceps Walsh, nymph
16 Part of labium of Gomphus spiniceps Walsh, nymph

From the *Canadian entomologist,* 1897, v. 29, pl. 7, "Preliminary studies of North American Gomphinae," by James G. Needham.

PLATE 21

Cordulinae

FIG.
1 Somatochlora elongata Selys. Photo from life by J. G. Needham
2 Cast nymph skin of Epicordulia princeps Hagen: drawn by Mrs Needham

PLATE 22

Cordulinae

FIG.
1 Epicordulia princeps Hagen, ♀: drawing by Mrs Needham
2 Tetragoneuria spinosa Selys, ♀ showing peculiar wing markings. Photo by H. N. Howland.

PLATE 23

Libellulinae

FIG.
1 Libellula semifasciata Burm.
2 L. pulchella Dru.

PLATE 24

Libellulinae

FIG.
1 Plathemis lydia Dru.
2 Celithemis eponina Dru.
3 Perithemis domitia Dru. ♂
4 P. domitia Dru. ♀

PLATE 25

Nymphs of Sympetrum

FIG.
1 Sympetrum illotum Hagen
2 Sympetrum semicinctum Say

PLATE 26

Neuroptera

FIG.

1 Chauliodes serricornis Say, newly transformed. The cast off pupal skin is seen hanging out of burrow in rotten wood. Photo from life by J. G. Needham

2 Polystoechotes punctatus Say. Photo by J. G. Needham

PLATE 27

Chauliodes serricornis Say

a A pair *in copulo* beneath a leaf of the flowering fern (Osmunda regalis L.; a large number of eggs already present.

b Same pair, enlarged

c Female of the same pair, ovipositing later

Photos from life by J. G. Needham

PLATE 28

Horned Corydalis, Corydalis cornuta Linn.: [a]the larva; [b]the pupa [c]the male imago; [d]head and thorax of the female (after Riley)

PLATE 29

Sialis infumata Walk.

FIG.

1 Wing of the imago

2 Lateral view of the pupa

3 Dorsal view of the larva

Drawings by Miss Anthony

PLATE 30

Caddis flies (Trichoptera)

FIG.

1 Phryganea cinerea Walker

2 Goniotaulius dispectus Walker

3 Halesus indistinctus Hagen

PLATE 31

Caddis flies (Trichoptera)

FIG

1 Halesus hostis Hagen

2 H. sp.?

PLATE 32

Caddis flies (Trichoptera)

FIG.

1 Larva of Halesus sp.? no. 3, dorsal view

2 Larva of Halesus sp.? no. 2, dorsal view

3 Larva of Halesus sp.? no. 1, dorsal view

4 Pupa of Halesus sp.? no. 3, lateral view

5 Pupa of Halesus sp.? no. 2, lateral view

6 Pupa of Halesus sp.? no. 1, lateral view

PLATE 33

Caddis fly cases and eggs

FIG.

1 Larval case of Halesus sp.? no. 3
2 Larval case of Halesus sp.? no. 2
3 Larval case of Halesus sp.? no. 1
4 Egg ring of an unknown caddis fly. Photo by C. Betten from life

PLATE 34

Caddis flies (Trichoptera)

FIG.

1 Leptocerus resurgens Walker
2 Triaenodes ignita Walker
3 Hydropsyche scalaris Hagen

PLATE 35

Diptera

FIG.

1 Stratiomyia badius Walker; drawing by Miss Anthony
2 Tipula abdominalis Say, photo by H. N. Howland

PLATE 36

Larvae of Diptera

FIG.

1 Dorsal view of larva of Tipula abdominalis Say
2 End of abdomen of same, more enlarged
3 *a* Dorsal prolegs of one segment of larva of Sepedon fuscipennis Loew (developed for crawling beneath the surface film)
b End of abdomen of larva of Sepedon fuscipennis Loew
4 End of abdomen of larva of Tetanocera pictipes Loew

Outlet of Little Clear pond—view from the railroad

Photo by J. G. Needham

Photo by J. G. Needham

Little Clear pond—view from the outlet toward Green hill. St Regis mountain in the distance

Photo by C. Betten

Little Clear creek on the grounds of the Adirondack hatchery, looking downstream from the railroad

Photo by R. C. Spears

Little Clear creek below the hatchery

Photo by J. G. Needham

Little Clear creek at edge of woods below the hatchery. Cages, nets and trap lantern

Photo by J. G. Needham

Little Clear creek on the hatchery grounds looking toward the railroad

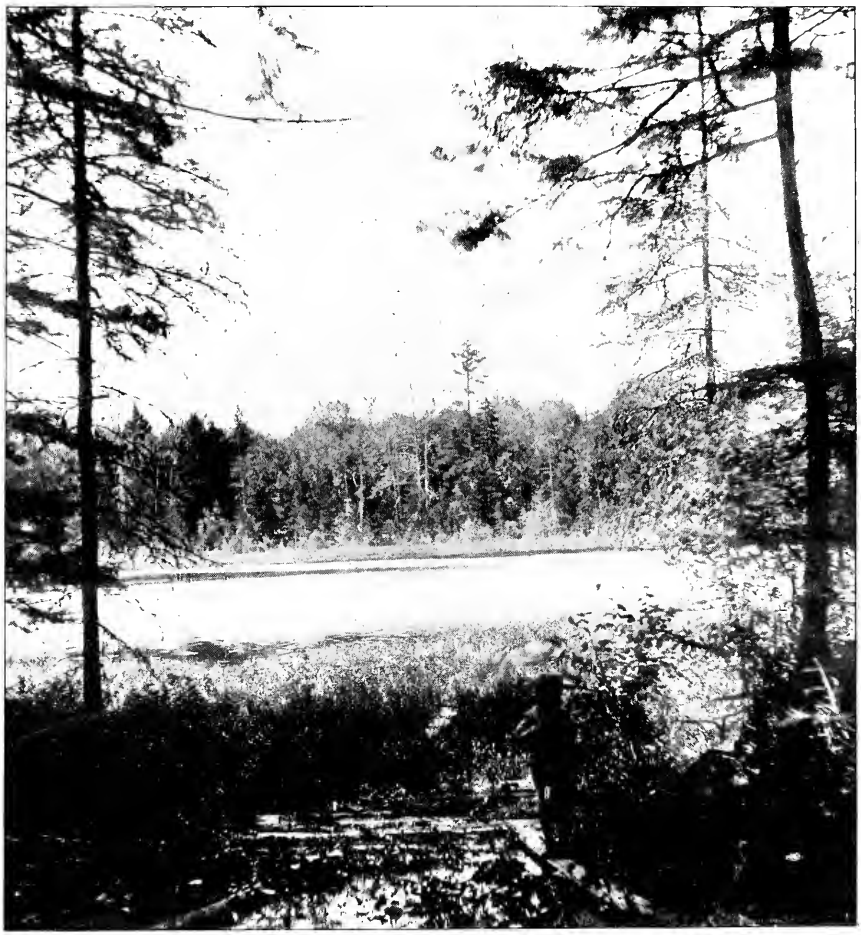


Photo by J. G. Needham

General view of Little Bog pond

Photo by C. Betten

Shore of Little Bog pond

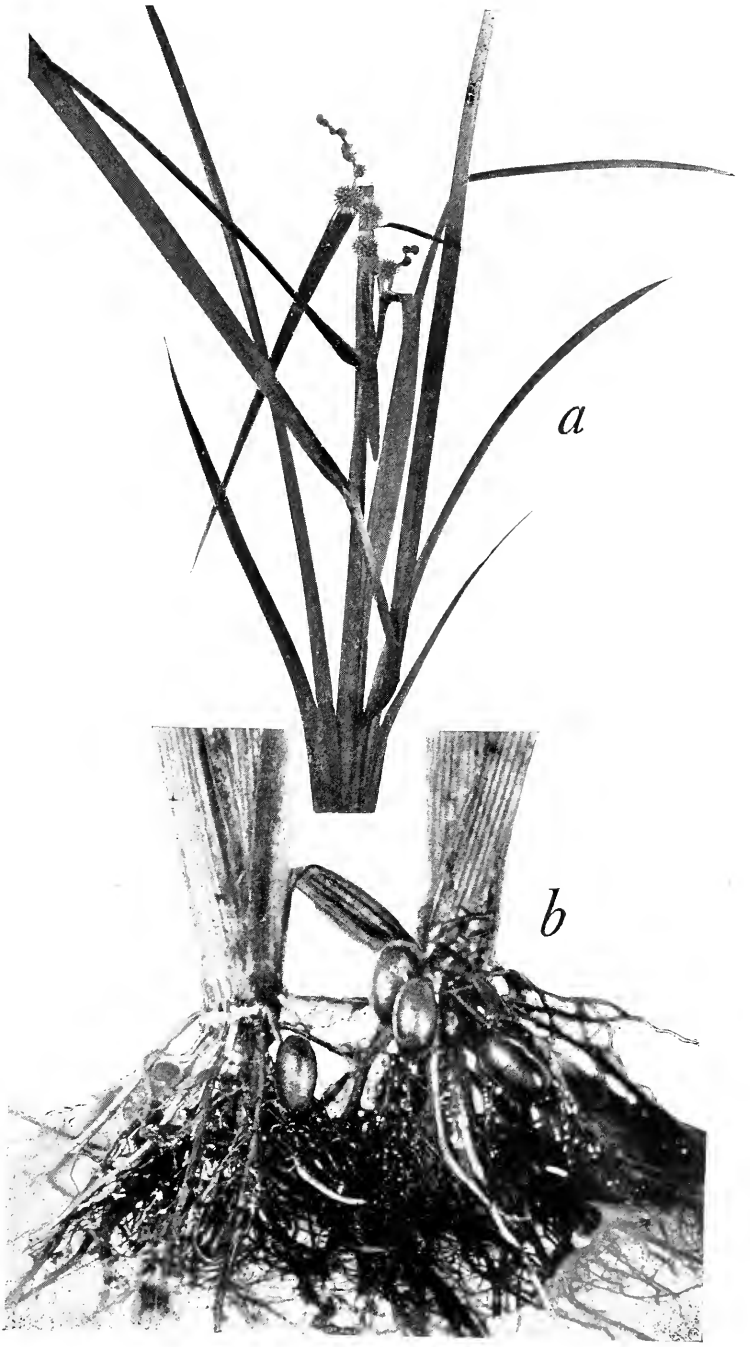
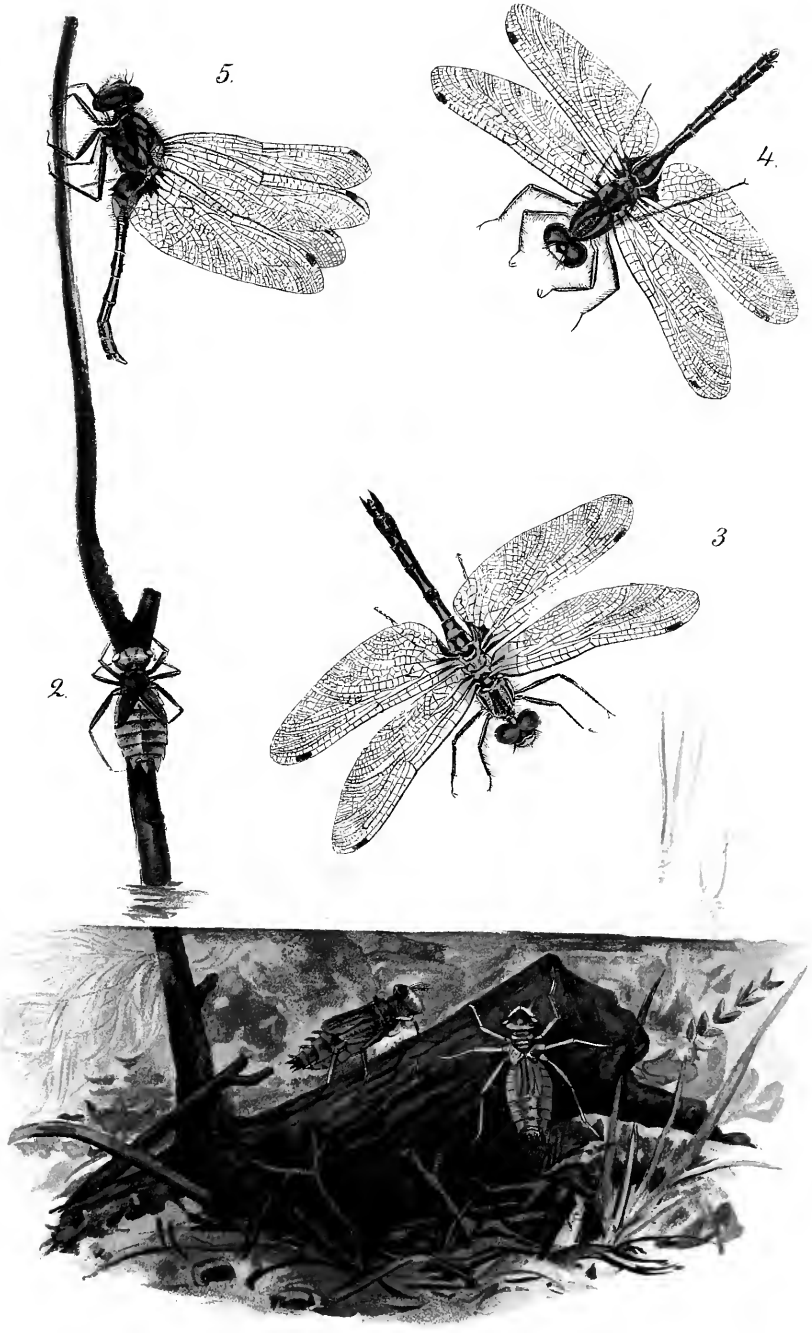


Photo from life, by J. G. Needham

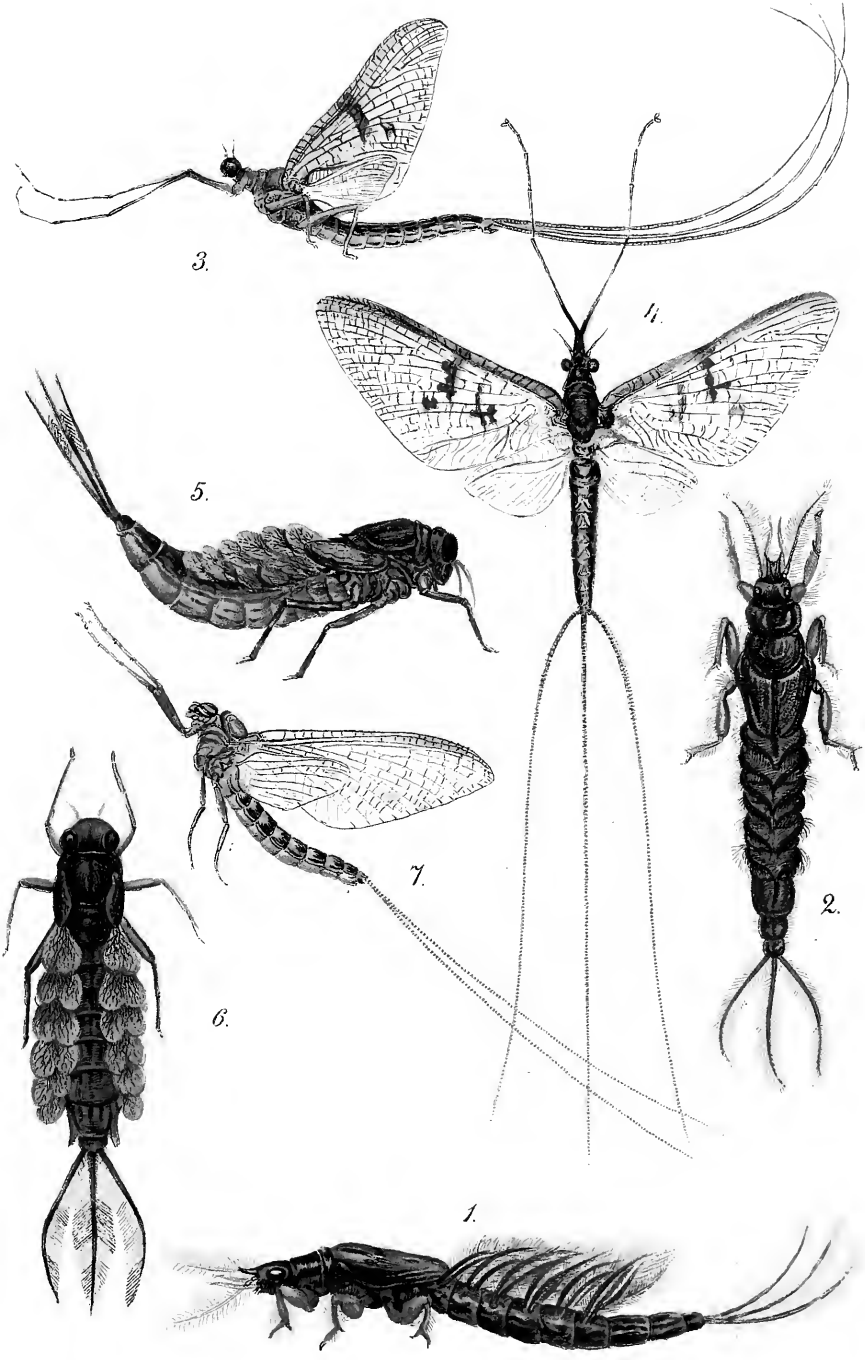
Sparganium with long-horned leaf-beetles (Donacia): larval and pupal cases on the roots



L. H. Joutel, 1900

James B. Lyon, State Printer

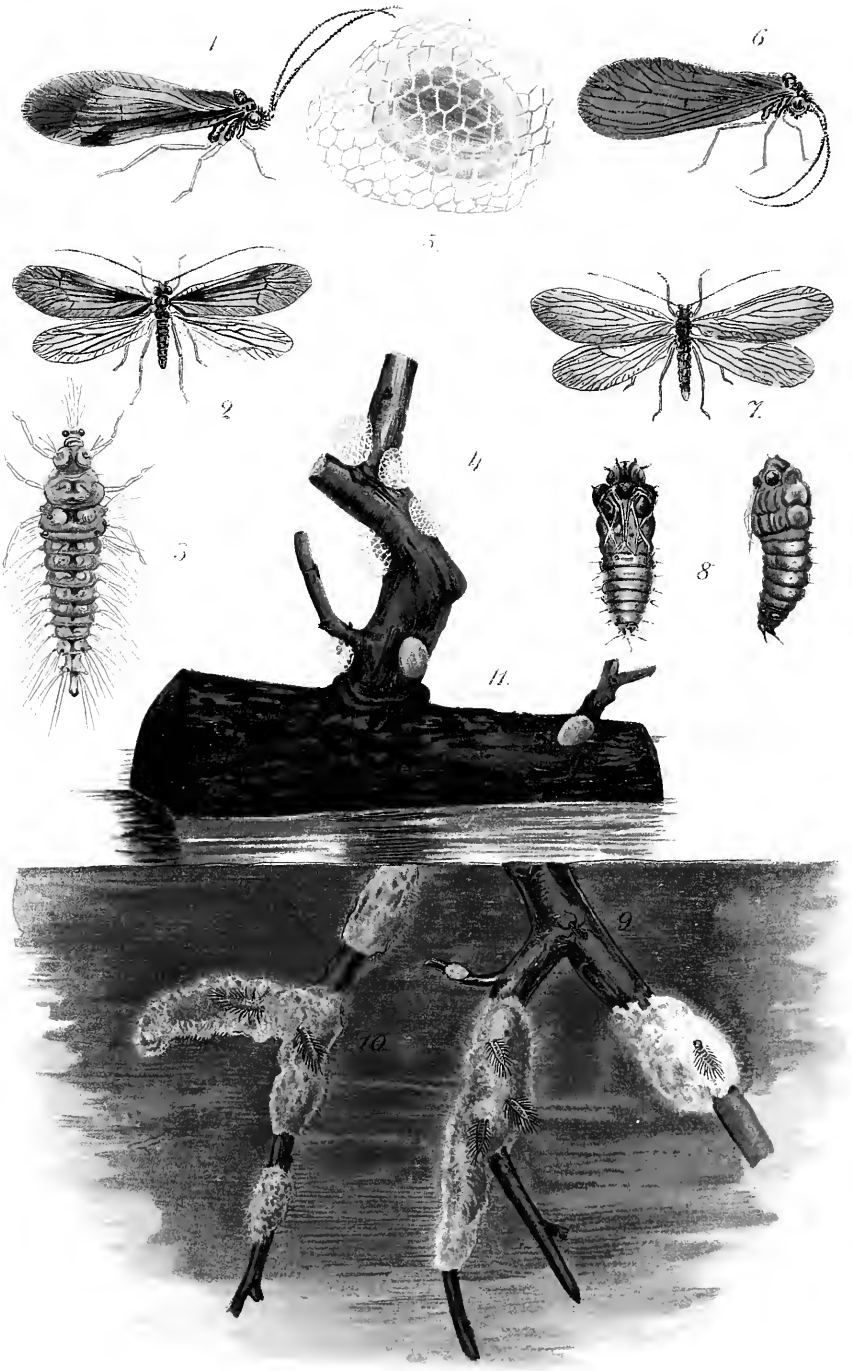
Leucorhinia glacialis



L. H. Joutel, 1900

James B. Lyon, State Printer

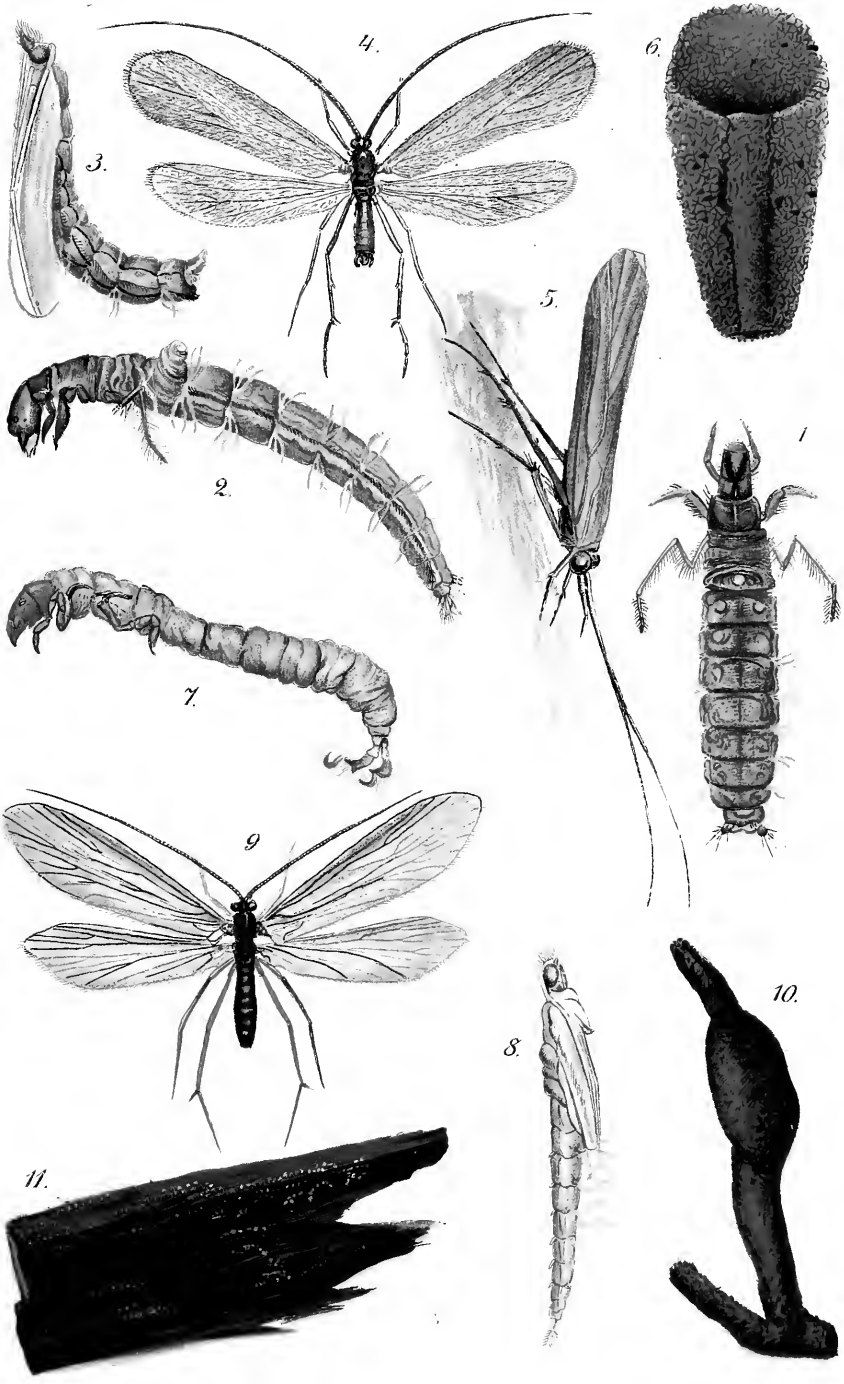
Mayflies



L. H. Joutel, 1900

James B. Lyon, State Printer

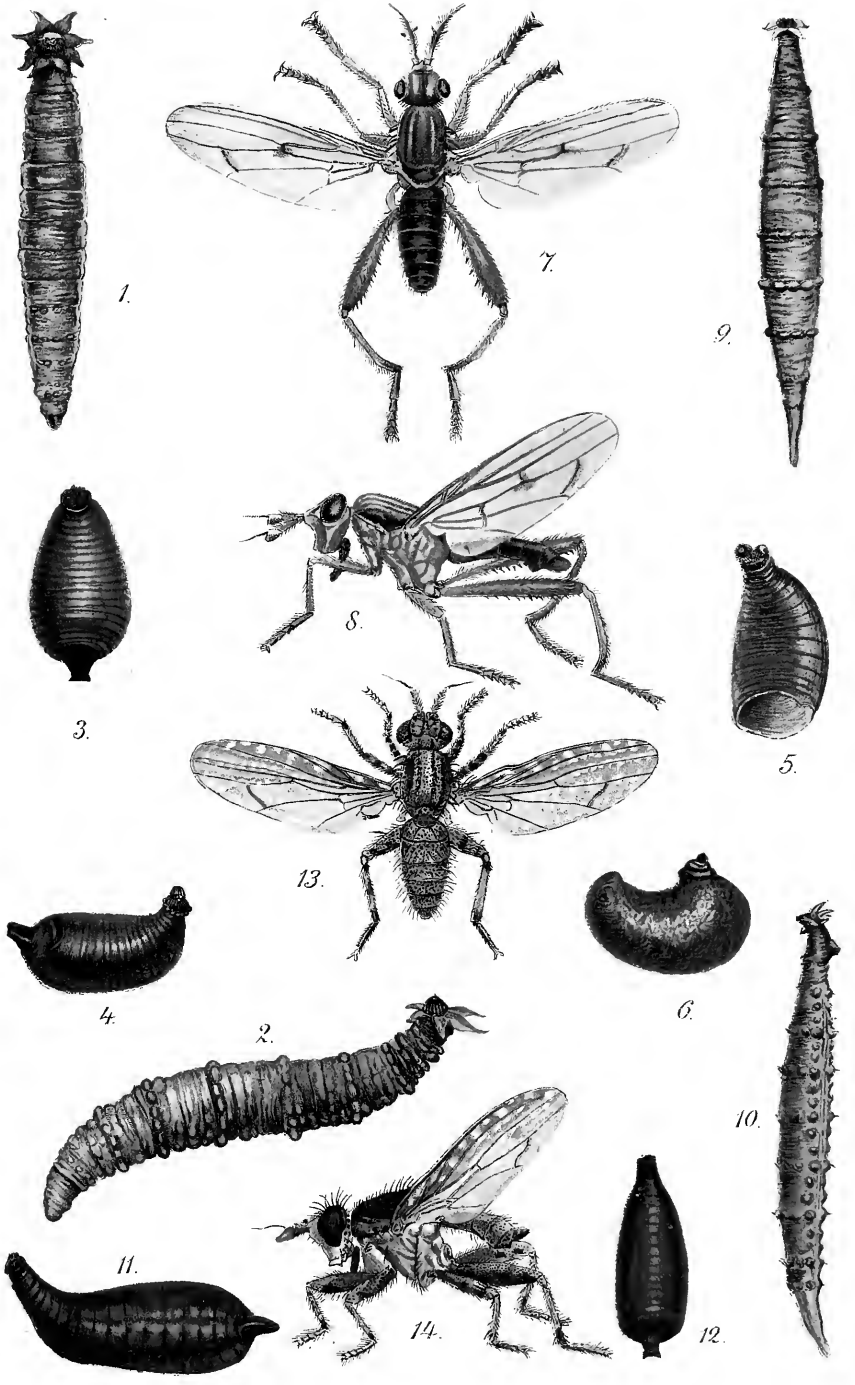
Spongilla flies



L. H. Joutel, 1900

James B. Lyon, State Printer

Caddis flies



L. H. Joutel, 1900

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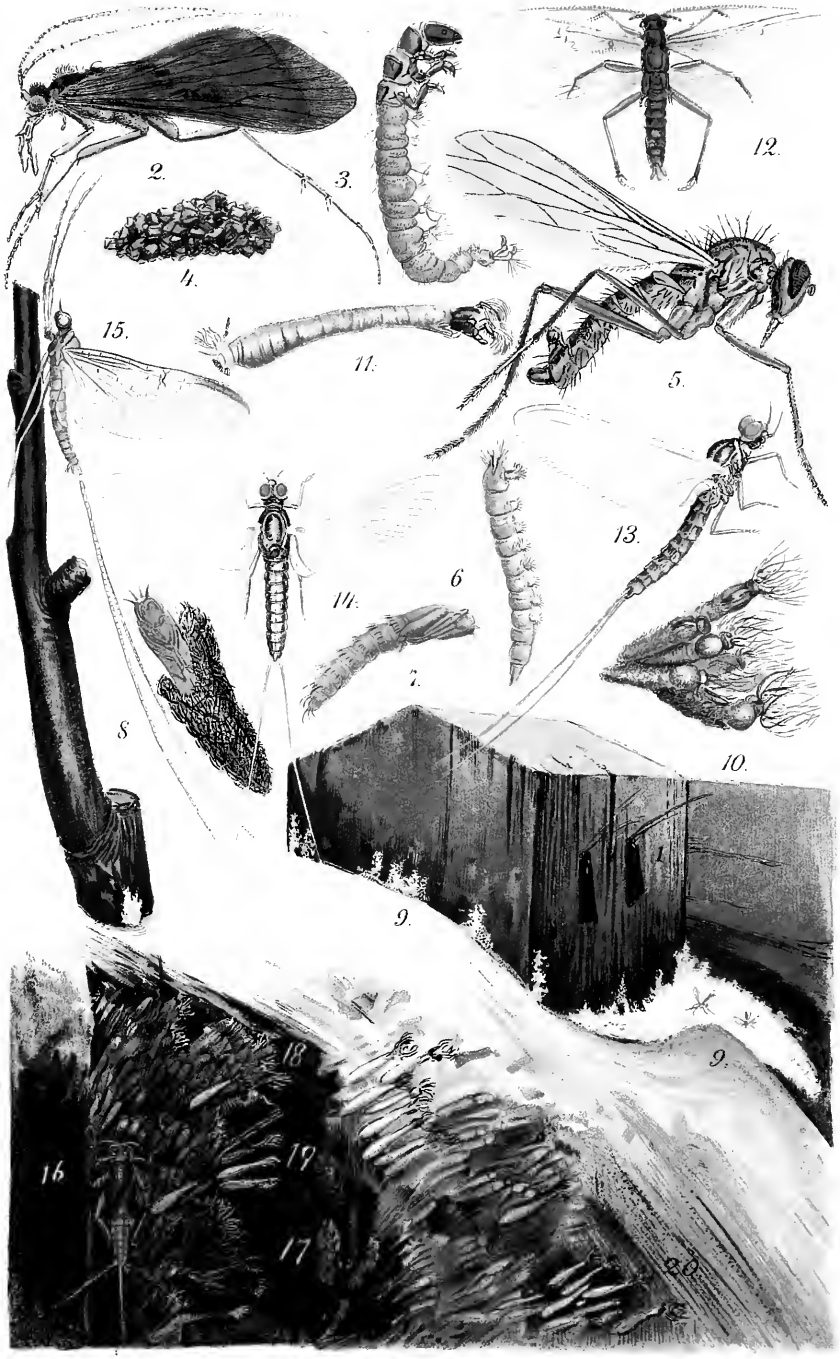
Sepedon and Tetanocera



L. H. Joutel, 1900

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Simulium society

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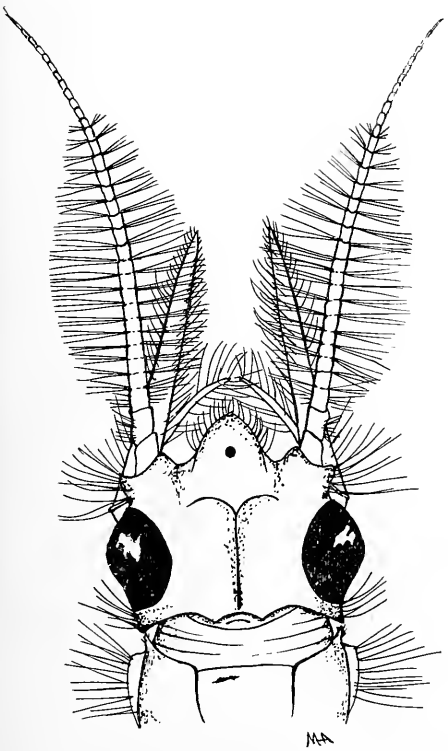

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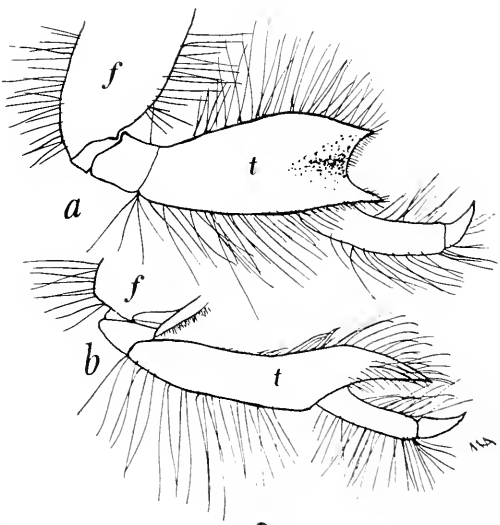

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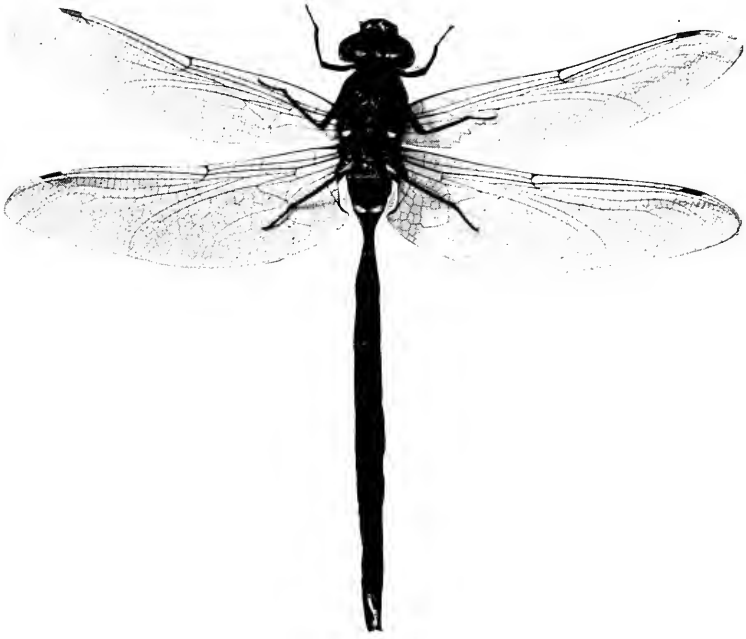
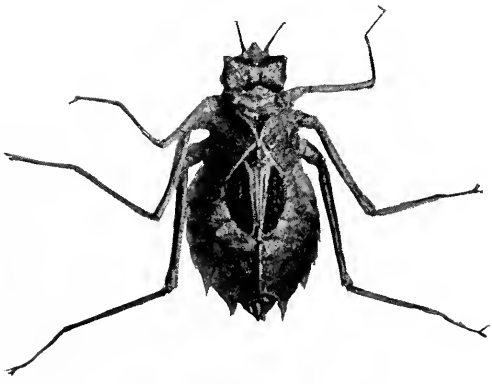
Hexagenia variabilis Etn.



1

2

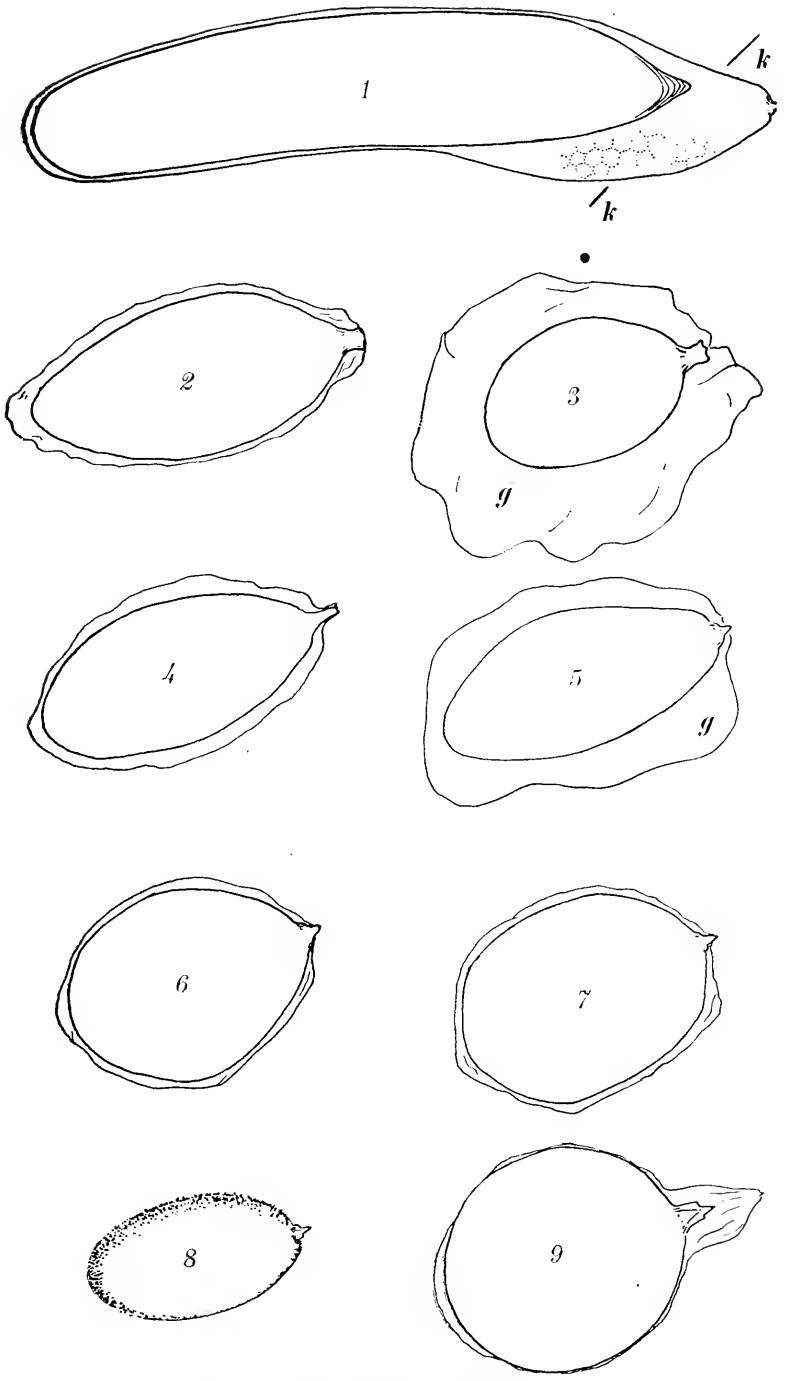
1 Aeschna constricta Say
2 Gomphus scudderi Selys



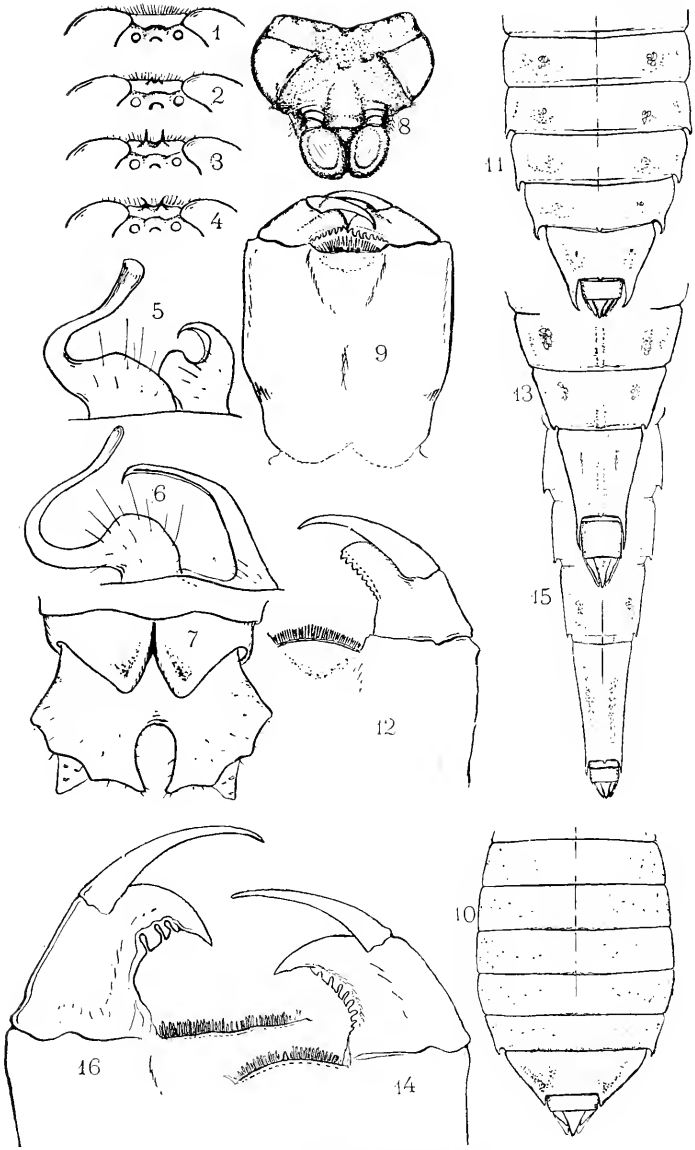
8

Photos by J. G. Needham

Dragon-fly nymphs



Eggs of nine genera of dragon-flies



From *Canadian entomologist* v. 29, pl. 7 (1897)

Structural characters of Gomphinae

Photo from life by J. G. Needham

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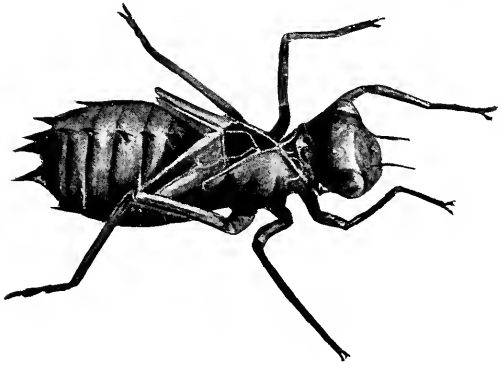


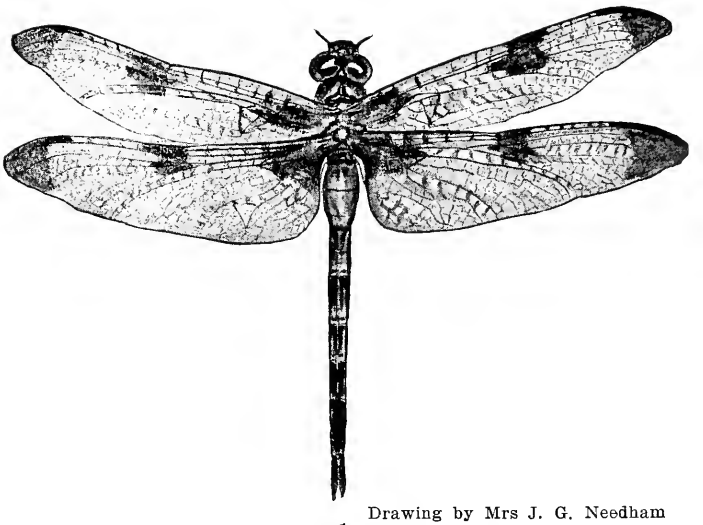
Drawing by Mrs J. G. Needham

2

1 Somatochlora elongata Selys

2 Epicordulia princeps Hagen

CORDULINAE



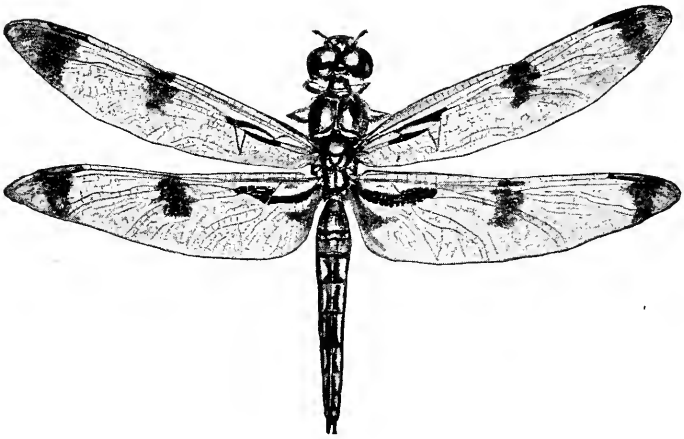
Drawing by Mrs J. G. Needham

1

Photo by H. N. Howland

2

1 Epicordulia princeps Hagen ♀
2 Tetragoneuria spinosa Selys ♀ nat. size



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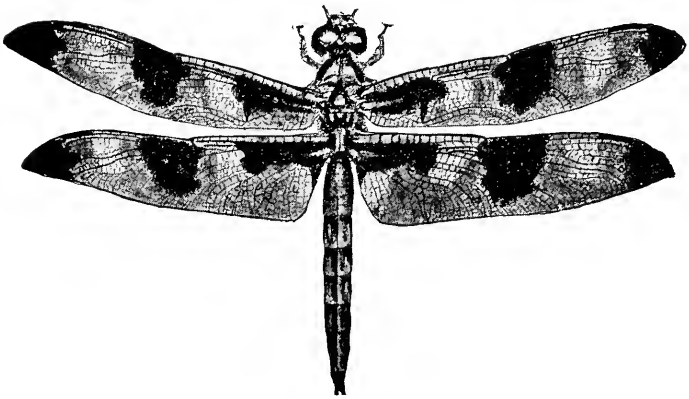
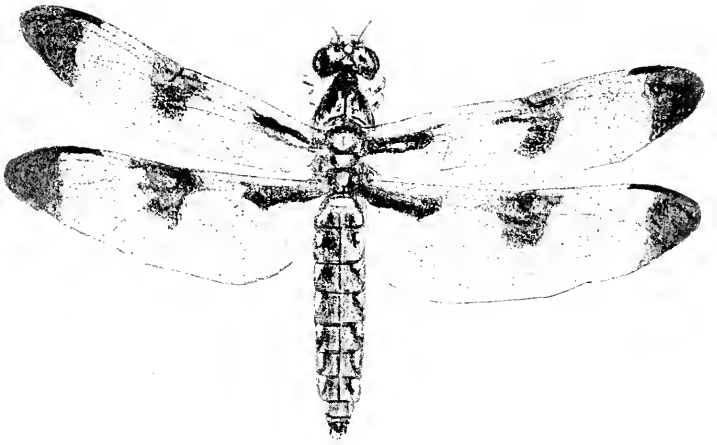


2

1 Libellula semifasciata Burm.
2 Libellula pulchella Dru.

LIBELLULINAE



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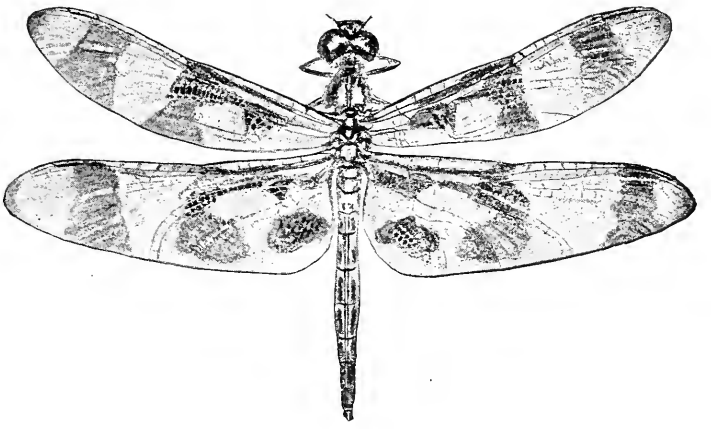

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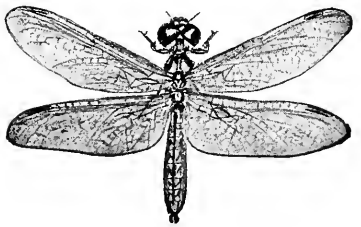

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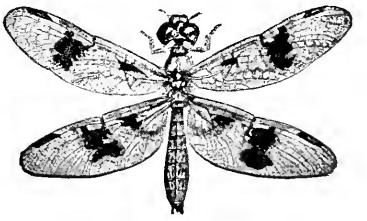
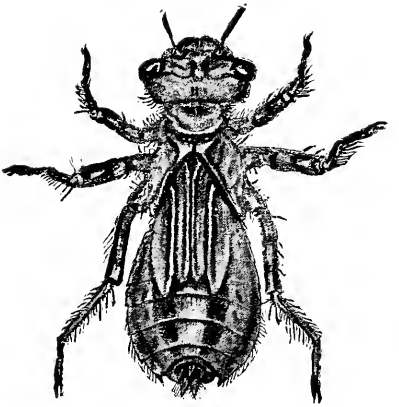


4

1 Plathemis lydia Drury
2 Celithemis eponina Drury
3, 4 Perithemis domitia Drury, ♂ and ♀

LIBELLULINAE



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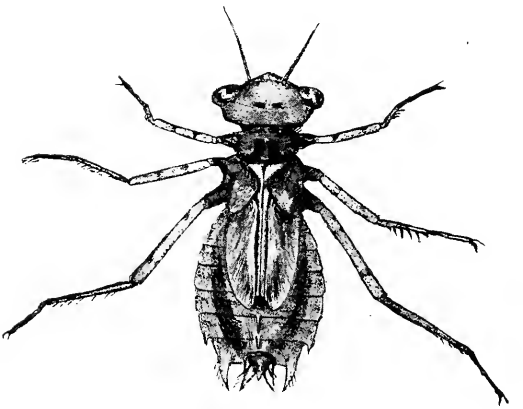


2

1 S. illotum Hagen
2 S. semicinctum Say

NYMPHS OF SYMPETRUM

Photo from life by J. G. Needham, nat. size

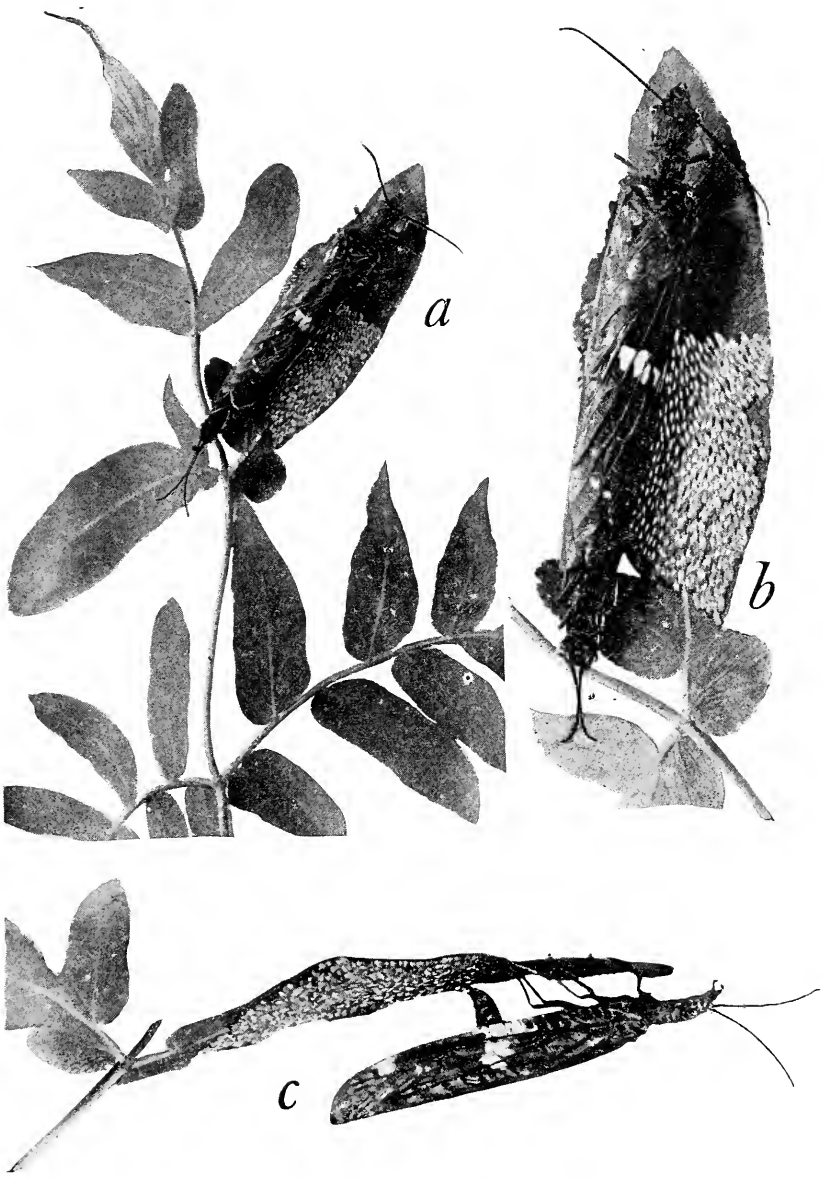
1

Photo of living but partly anesthetized specimen by J. G. Needham

2

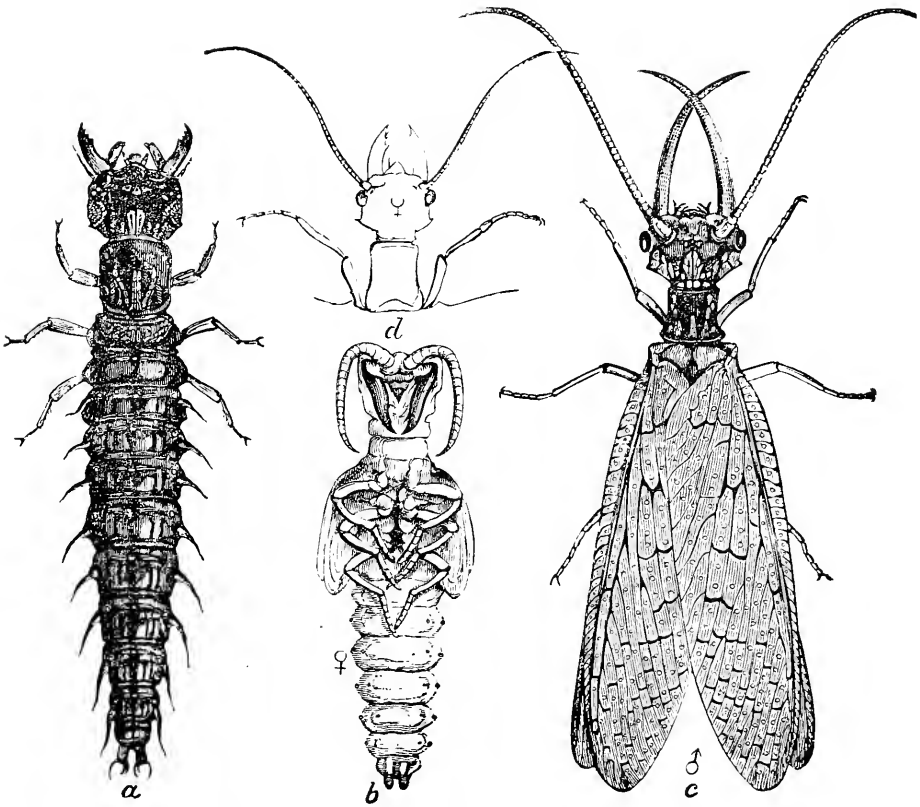
1 Chauliodes serricornis Say, newly transformed

2 Polystoechotes punctatus Say

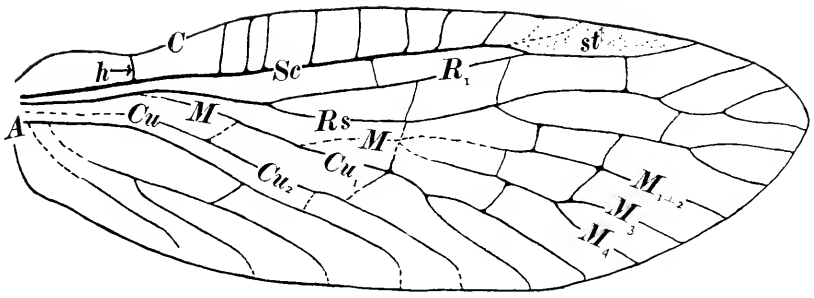


Photos from life by J. G. Needham

Chauliodes serricornis Say



Horned Corydalis, Corydalis cornuta (After Riley)



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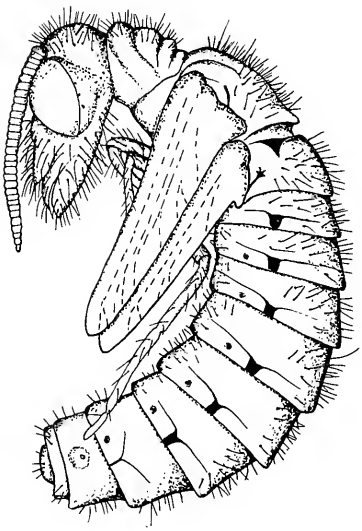

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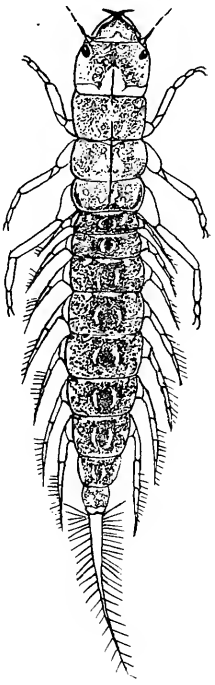
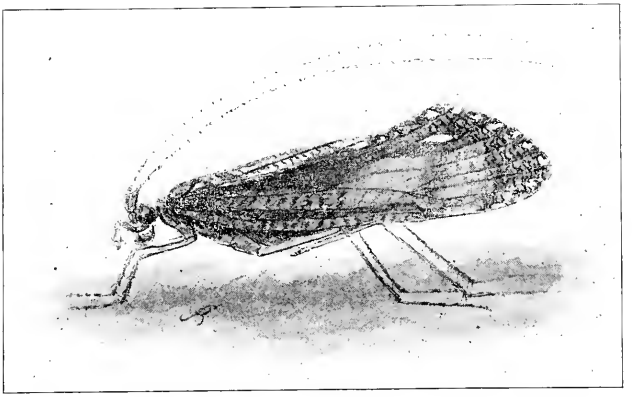


3

Drawings by Miss Anthony

Sialis infumata Walk



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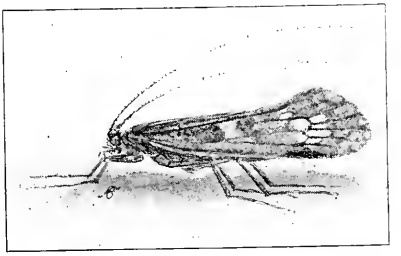

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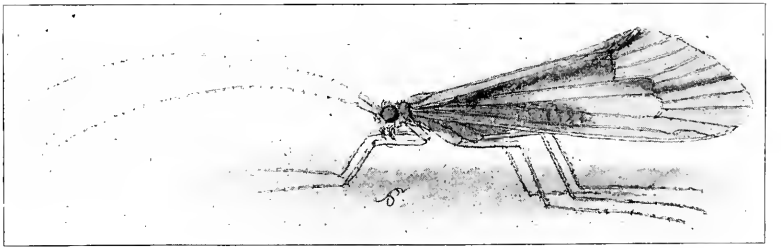
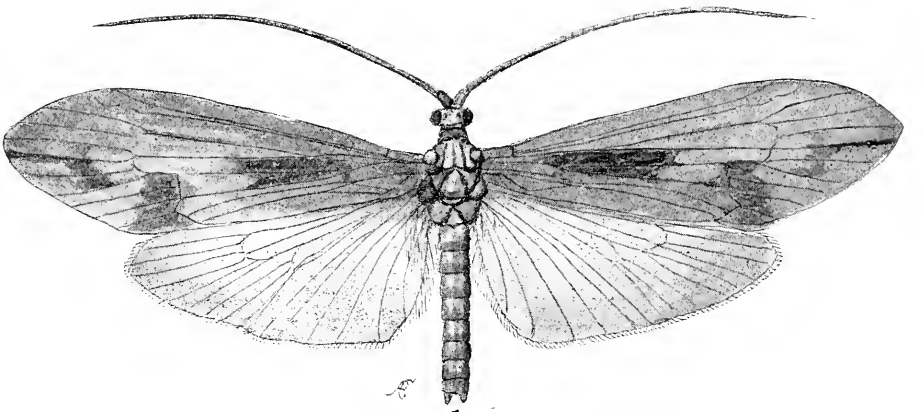


3

Drawings by Mrs J. H. Comstock

1 Phryganea cinerea Walk.
2 Goniotaulius dispectus Walk.
3 Halesus indistinctus Hagen

CADDIS FLIES



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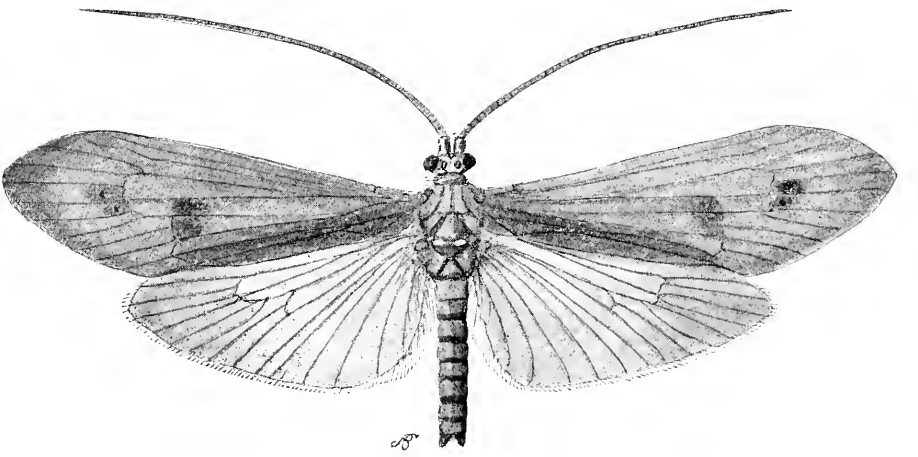
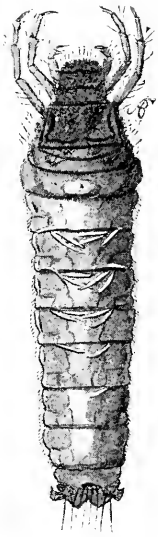


2

Drawings by Mrs J. H. Comstock

1 Halesus hostis Hagen
2 Halesus species

CADDIS FLIES



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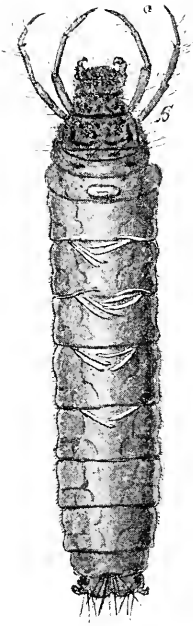

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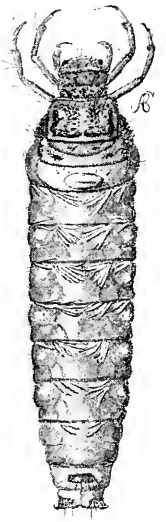

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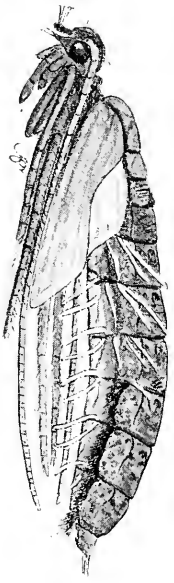

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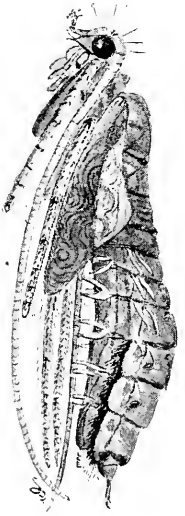
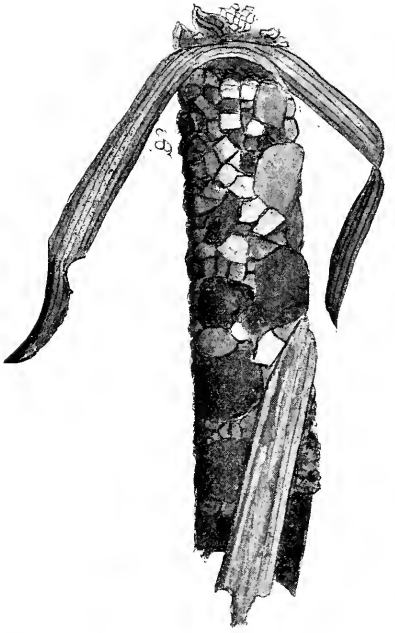


5

6

Drawings by Mrs J. H. Comstock

Caddis flies larvae and pupae



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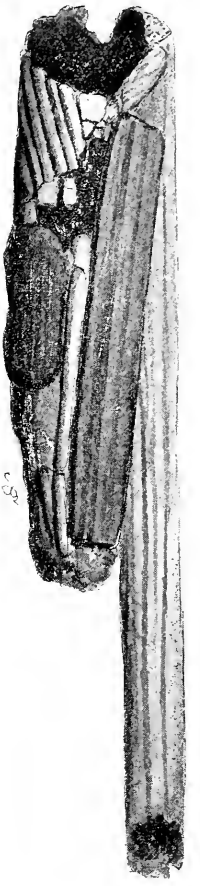

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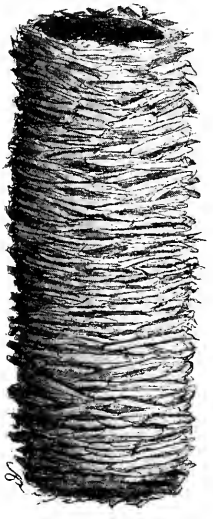


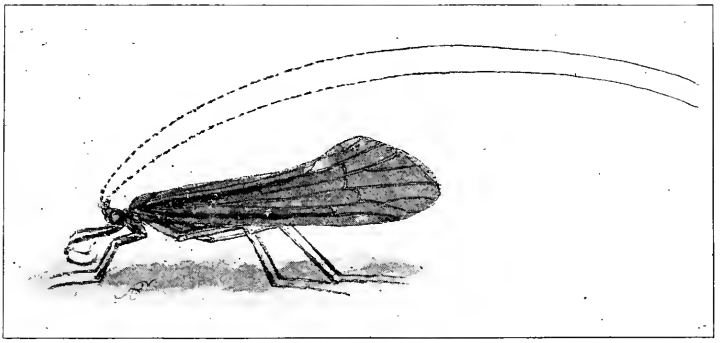
3

Photo from life by C. Betten

4

Drawings (fig. 1-3) by Mrs J. H. Comstock

Caddis fly cases and eggs



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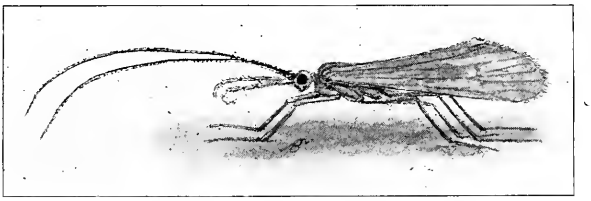

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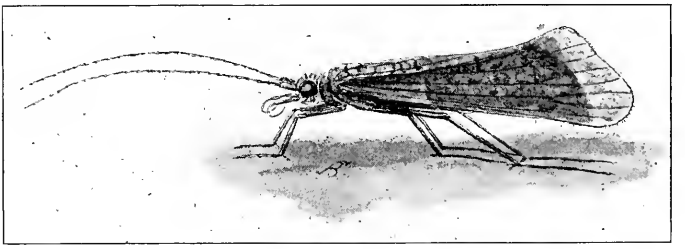
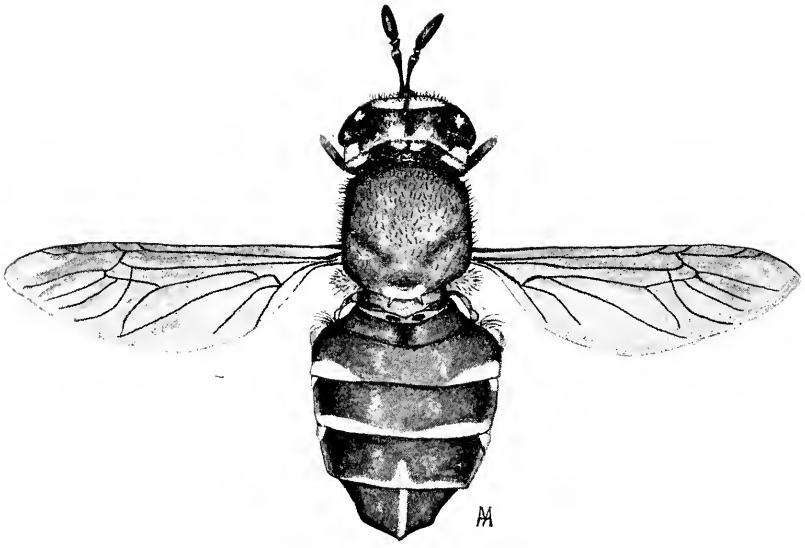


3

Drawings by Mrs J. H. Comstock

1 Leptocerus resurgens Walk.
2 Triaenodes ignita Walk.
3 Hydropsyche scalaris Hagen

CADDIS FLIES



Drawing by Miss Anthony

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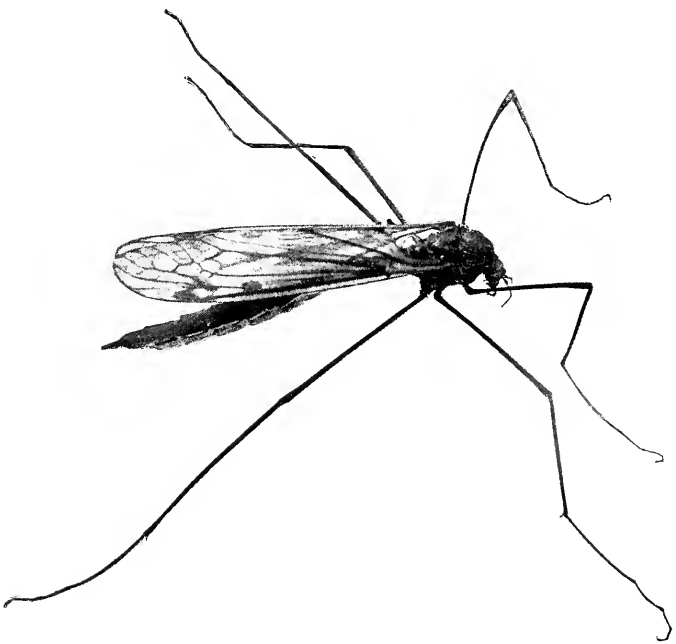
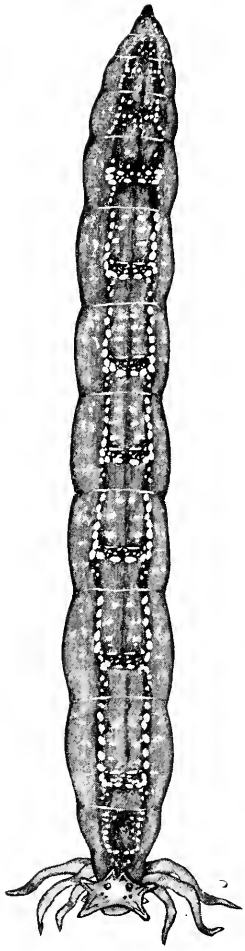


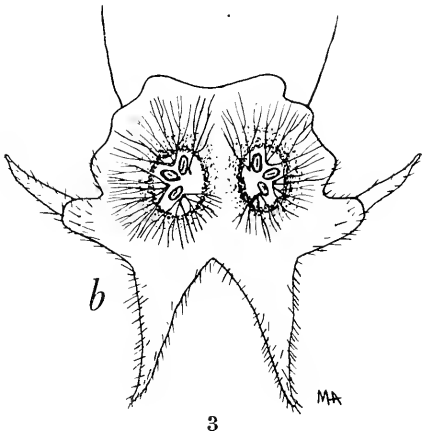
Photo by H. N. Howland

2

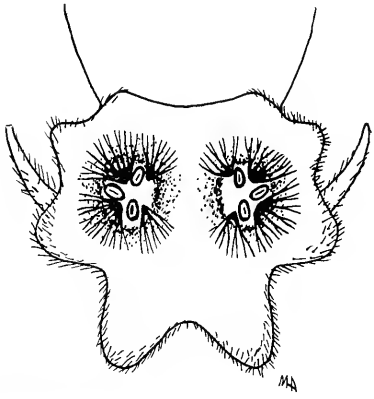
1 Stratiomyia badius Walk.
2 Tipula abdominalis Say ♀ nat. size



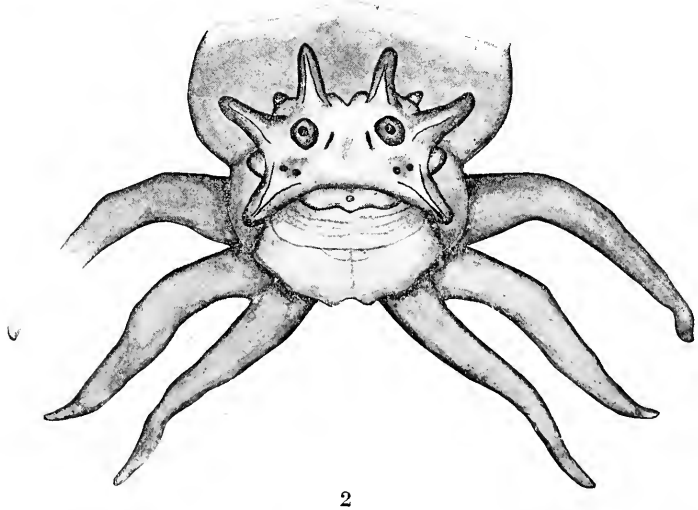
1



3



4



2

1, 2 Tipula abdominalis Say
3 Sepedon fuscipennis Loew
4 Tetanocera pictipes Loew

Fig. 3, 4. Drawings by Miss Anthony

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State Museum

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